



UNIVERSITY OF SARGODHA
OFFICE OF THE REGISTRAR
(ACAD BRANCH)

NOTIFICATION

On the recommendations of Academic Council made in its 19th (4/2023) meeting held on 13.09.2023, the Syndicate in its 64th (4/2023) meeting held on 03.11.2023 approved the revised curriculum of BS in Physics (5th Semester Intake) for implementation w.e..f. Fall 2025 (Annex-'A').


(WAQAR AHMAD)
Additional Registrar (General)

Dated: 06.11.2025

No. SU/Acad/25/ 1203

Distribution:

- Chairman Department of Physics
- Controller of Examinations
- Director Academics

C.C:

- Dean Faculty of Sciences
- Director, QEC
- Additional Registrar (A & R) *{With the request to forward the notification alongwith curriculum to all Principals of affiliated colleges concerned}*
- Secretary to the Vice-Chancellor
- PA to Registrar
- Notification File

SCHEME OF STUDIES

BS Physics (5th Semester Intake)

(W.e.f. FALL-2025)



DEPARTMENT OF PHYSICS

UNIVERSITY OF SARGODHA

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Dr.

Program Duration:
Teaching System:

Two Years
Semester System

Eligibility Requirements:

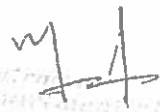
For Candidates having Associate Degree or equivalent in same field	<p>i) At least 45% marks in ADS (annual examination system) or equivalent qualification and 25% marks contribution of Physics and Mathematics courses each, to the total (like 200/800) is compulsory.</p> <p>ii) At least 2.0 CGPA out of scale 4.0 in Associate Degree in Physics (semester system) or equivalent qualification with 12 out of 60 credit hours of Physics and Mathematics each.</p>
For Candidates where disciplines of Associate Degree or equivalent and Undergraduate program are different	<p>i) At least 45% marks in ADS (annual examination system) or equivalent qualification and 25% marks contribution of Physics and Mathematics courses each, to the total (like 200/800) is compulsory.</p> <p>ii) At least 2.0 CGPA out of scale 4.0 in ADS (semester system) or equivalent qualification with 12 out of 60 credit hours of Physics and Mathematics each.</p> <p>iii) The student must passed deficiency courses</p>

1. General Courses

Sr. No.	Course Code	Course Title	Credit Hours	Prerequisite
1.	URCG-5129	Understanding of Holy Quran-I OR	1 (0-1)	Nil
	URCG-5131	Ethics-I only for Non-Muslim		
2.	URCG-5130	Understanding of Holy Quran-II OR	1 (0-1)	Nil
	URCG-5132	Ethics-II only for Non-Muslim		
Total Credit Hours			✓	02

2. Single Major Courses:

Sr. No.	Course Code	Course Title	Credit Hours	Prerequisite
1.	PHYS-6109	Methods of Mathematical Physics-I	3(3-0)	Nil
2.	PHYS-6110	Classical Mechanics-I	3(3-0)	Nil
3.	PHYS-6111	Electromagnetism-I	3(3-0)	Nil
4.	PHYS-6112	Electronics	3(3-0)	Nil
5.	PHYS-6113	Electronics Lab	3(0-3)	Nil
6.	PHYS-6114	Methods of Mathematical Physics-II	3(3-0)	PHYS-6109
7.	PHYS-6115	Classical Mechanics-II	3(3-0)	PHYS-6110
8.	PHYS-6116	Electromagnetism-II	3(3-0)	PHYS-6111
9.	PHYS-6117	Quantum Mechanics-I	3(3-0)	Nil
10.	PHYS-6118	Solid State Physics-I	3(3-0)	Nil
11.	PHYS-6119	Modern Physics Lab	3(0-3)	Nil
12.	PHYS-6120	Statistical Mechanics	3(3-0)	Nil
13.	PHYS-6121	Atomic and Molecular Physics	3(3-0)	Nil
14.	PHYS-6122	Plasma Physics	3(3-0)	Nil
15.	PHYS-6123	Quantum Mechanics-II	3(3-0)	PHYS-6117
16.	PHYS-6124	Solid State Physics-II	3(3-0)	PHYS-6118
17.	PHYS-6126	Computational Physics	3(3-0)	Nil


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18.	PHYS-6127	Laser Physics	3(3-0)	Nil
19.	PHYS-6128	Relativity and Cosmology	3(3-0)	Nil
20.	PHYS-6129	Nuclear and Elementary Particle Physics	3(3-0)	Nil
21.	PHYS-XXX	Optional	3(3-0)	Nil
Major Courses Credit Hours Total			63	

3. Field experience/internship: Minimum 03 credit hours:

Lasting 6-8 weeks and ideally scheduled during summer breaks after 6th semester.

1.	PHYS-6108	Field Experience/Internship	3(0-3)	Nil
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4. Capstone Project: Minimum 03 credit hours:

This project, after the sixth semester, requires faculty supervision and evaluation following department guidelines

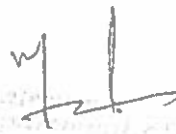
1.	PHYS-6125	Capstone project	3(0-3)	Nil
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**List of Deficiency Courses
BS in Physics (5th Semester Intake)**

The deficiency courses (if applicable) will be determined after admission to BS Physics (after 14-years Education), which is variable for different university students due to different scheme of studies offered to them.

Course Code	Course Title	Credit Hours	Pre-Requisite
PHYS-5101	Mechanics ✓	3(3-0)	Nil
PHYS-5102	Waves and Oscillations ✓	3(3-0)	Nil
PHYS-5103	Introduction to Electromagnetism ✓	4(3-1)	Nil
PHYS-5104	Modern Physics ✓	3(3-0)	Nil
PHYS-5106	Theory of Thermodynamics ✓	3(3-0)	Nil
MATH-5101	Calculus-I ✓	3(3-0)	Nil
MATH-5104	Calculus-II ✓	3(3-0)	Nil
MATH-5105	Linear Algebra ✓	3(3-0)	Nil
MATH-5109	Ordinary Differential Equations ✓	3(3-0)	Nil

- (a) The deficiency courses will be offered during regular Semester-V, VI, VII, and VIII. Chairman, Department of Physics will be authorized to decide the deficiency courses of each student those who got admission (in the Department of Physics, UOS) after Associate Degree other than Physics or University of Sargodha and the courses will be offered from the above list as per availability of the resources.
- (b) Credit hours of Deficiency courses will not be included for computation of GPA/CGPA. Student will pass these courses (if offered).
- (c) In case of deficiency Courses related to Mathematics, the Calculus-I will be offered in 5th Semester, Calculus-II will be offered in 6th Semester, Linear Algebra in 7th Semester and Ordinary Differential Equations in 8th Semester. These courses will replace the deficiency Course related to Physics.
- (d) Student can take one optional course in semester VIII from the list of optional courses. The courses will be offered as per availability of the resources.


 Chair
 Department of Physics
 University of Sargodha

Scheme of Studies BS-Physics (5th Semester Intake)

Semester-V

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-1	PHYS-6109	Methods of Mathematical Physics-I ✓	3(3-0)	Nil
Major-2	PHYS-6110	Classical Mechanics-I ✓	3(3-0)	Nil
Major-3	PHYS-6111	Electromagnetism-I ✓	3(3-0)	Nil
Major-4	PHYS-6112	Electronics ✓	3(3-0)	Nil
Major-5	PHYS-6113	Electronics Lab ✓	3(0-3)	Nil
GE-I	URCG-5129	Understanding of Holy Quran-I OR ✓	1 (0-1)	Nil
	URCG-5131	Ethics-I only for Non-Muslim ✓		
Deficiency-I	PHYS-5101	Mechanics	3(3-0)	Nil
Deficiency-II	PHYS-5102	Waves and Oscillations	3(3-0)	Nil

Semester Total Credit Hours: 16

Semester-VI

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-6	PHYS-6114	Methods of Mathematical Physics-II ✓	3(3-0)	PHYS-6109
Major-7	PHYS-6115	Classical Mechanics-II ✓	3(3-0)	PHYS-6110
Major-8	PHYS-6116	Electromagnetism-II ✓	3(3-0)	PHYS-6111
Major-9	PHYS-6117	Quantum Mechanics-I ✓	3(3-0)	Nil
Major-10	PHYS-6118	Solid State Physics-I ✓	3(3-0)	Nil
Major-11	PHYS-6119	Modern Physics Lab ✓	3(0-3)	Nil
Deficiency-III	PHYS-5103	Introduction to Electromagnetism	4(3-1)	Nil

Semester Total Credit Hours: 18

Semester-VII

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-12	PHYS-6120	Statistical Mechanics ✓	3(3-0)	Nil
Major-13	PHYS-6121	Atomic and Molecular Physics ✓	3(3-0)	Nil
Major-14	PHYS-6122	Plasma Physics ✓	3(3-0)	Nil
Major-15	PHYS-6123	Quantum Mechanics-II ✓	3(3-0)	PHYS-6117
Major-16	PHYS-6124	Solid State Physics-II ✓	3(3-0)	PHYS-6118
GE-II	URCG-5130	Understanding of Holy Quran-II ✓	1 (0-1)	Nil
	URCG-5132	Ethics-II only for Non-Muslim ✓		
Compulsory	PHYS-6125	Capstone Project ✓	3(0-3)	Nil
Deficiency-IV	PHYS-5104	Modern Physics	3(3-0)	Nil

Semester Total Credit Hours: 19

Semester-VIII

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-17	PHYS-6126	Computational Physics ✓	3(3-0)	Nil
Major-18	PHYS-6127	Laser Physics ✓	3(3-0)	Nil
Major-19	PHYS-6128	Relativity and Cosmology ✓	3(3-0)	Nil
Major-20	PHYS-6129	Nuclear and Elementary Particle Physics ✓	3(3-0)	Nil
Major-21	PHYS-61xx	Optional Course	3(3-0)	Nil
Deficiency-V	PHYS-5106	Theory of Thermodynamics	3(3-0)	Nil

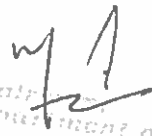
Semester Total Credit Hours: 15

Field Experience/Internship (after 6th Semester): 03

Total Credit Hours: 71

Optional Courses

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Opt-1	PHYS-6130	Physical and Geometrical Optics ✓	3(3-0)	Nil
Opt-2	PHYS-6131	Physics of Nanotechnologies ✓	3(3-0)	Nil
Opt-3	PHYS-6132	Methods of Experimental Physics ✓	3(3-0)	Nil
Opt-4	PHYS-6133	Introduction to Quantum Computing ✓	3(3-0)	Nil
Opt-5	PHYS-6134	Particle Physics ✓	3(3-0)	Nil
Opt-6	PHYS-6135	Advanced Electronics ✓	3(3-0)	Nil


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University of Sargodha
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Course Brief:

This course provides a wide range of analytical mathematical techniques essential to the solution of advanced problems in physics. The main objective is to have an in-depth understanding of the basics of complex analysis, the residue theorem, and its applications to integral solving techniques. This course enables the student to solve orthogonal functions, Beta functions, Factorial functions, Gamma functions, digamma and poly-gamma functions. It also enables the student to solve and apply Bessel functions, their kinds, and recurrence relations used in physics problems. This course will further extend the learning to solve second order differential equations using the concepts of Sturm-Liouville theory, Green's functions, and eigen valued problems.

Course Learning Objectives:

The course learning objectives are to understand the techniques of complex analysis, such as contour integral and analytic continuation and to develop an ability in students for solving problems related to special functions like Gamma, digamma, poly-gamma, Beta functions, Factorial functions and Green's functions.

Course Contents:

- 1 Function of complex variables and basic review
- 2 Analytical functions, harmonic functions
- 3 Cauchy Riemann equations
- 4 Differentiation of complex variables and Greens theorem
- 5 Integration of complex variables, Cauchy's theorem, and Cauchy's integral formula
- 6 Sequence and series in complex numbers (Taylor and Laurent expansions)
- 7 Calculus of residues and its basic concept
- 8 Evaluation of different integral types in residues
- 9 Dispersion relations
- 10 The gamma function (definition, types, and properties)
- 11 Factorial notations
- 12 Digamma and poly-gamma functions
- 13 Legendre duplication formula
- 14 Beta functions and its mathematical notations (Forms of Beta functions)
- 15 Incomplete beta functions
- 16 Stirling's series
- 17 Eigen functions and orthogonal functions
- 18 Strum-Liouville theory
- 19 Green's functions and properties
- 20 Bessel functions of first kind and orthogonality
- 21 Generating function, recurrence relations, integral form, and Jacobi series of Bessel functions
- 22 Modified and spherical forms of Bessel functions
- 23 Neumann and Hankel functions

Recommended Texts:

1. Arfken, G. B., Weber, H. J. & Harris, F. E. (2011). *Mathematical methods for physicists* (7th ed.). New York : Elsevier Science.
2. Kreyszig, E. (2011). *Advanced engineering mathematics* (10th ed.). New York: Wiley.

Suggested Readings:

1. Spiegel, M. R., Lipschutz, S., Schiller, J. J. & Spellman, D. (2009). *Schaum's outline of complex variables* (2nd ed.). New York: McGraw Hill Professional.
2. Wong, C. W. (2013). *Introduction to mathematical physics* (2nd ed.). Oxford: Oxford University Press.
3. Kakani, S. L. & Hemrajani, C. (2010). *Mathematical physics* (2nd ed.). New Delhi: CBS Publishers.

The fundamental goal of this course is to create understanding in students to classical mechanics and its applications. The focus in this course will be given to develop knowledge of the physical concepts and mathematical methods of classical mechanics to improve skills in formulating and solving physics problems. Students will learn the use of Newton's laws of motion, conservation theorems to solve advanced problems involving the dynamic motion of classical mechanical systems. This course provides the up-to-date treatment of classical mechanical systems so that students face least difficulty in understanding the advance topics covered in classical Mechanics II course.

Course Learning Objectives:

Upon successful completion of this course, the student will be able:

- 1- Understand the basic concepts of classical mechanics and analyze the world around them from a physics point of view;
- 2- Apply knowledge of classical mechanics to different everyday situations and apply classical mechanics formulism to solve various practical problems.
- 3- Validate a basic knowledge of Newton's Laws and equations of motion. Apply Newtonian mechanics to complex motion problems.
- 4- Understand the oscillatory motion and various types of oscillators.
- 5- To determine the gravitational potential, gravitation fled and hence gravitational force in the vicinity of various objects of different size and shapes.

Course Contents:

- 1 Historical background of classical mechanics
- 2 Concept of scalars vectors and coordinates transformations
- 3 Properties of orthogonal matrix
- 4 Vector products and proof of various identities of vectors
- 5 Velocity and acceleration in various coordinates
- 6 Gauss's divergence theorem and stokes theorem
- 7 The Newtonian formulation of mechanics and kinematics of particle motion
- 8 Force and types of force, problems about constant force acting upon the body and motion on inclined plane
- 9 Motion of the body in resistive medium solving the problem free falling object and motion of projectile and Atwood's machine
- 10 Conservation theorems: linear momentum, angular momentum and conservation of energy equilibrium and its type
- 11 Motion in electromagnetic field, equilibrium and nature of equilibrium
- 12 Oscillatory motion, free oscillator in one and two dimension
- 13 Damped oscillator and its types, under-damped, critically damper and over damped oscillator
- 14 forced oscillator
- 15 Physical oscillatory systems and electrical oscillation
- 16 Nonlinear oscillations.
- 17 Gravitation: gravitation and gravitational potential
- 18 Poisson's equations, Lines of force and equi-potential surfaces
- 19 Ocean Tides

Recommended Texts:

1. Thornton, S. T. & Marion, J. B. (2012). *Classical dynamics of particles and systems* (5th ed.). New York: Thomson Brooks/Cole

2. Tai L. Chow. (2010). *Classical mechanics*. (2nd ed). Taylor and Francis. California USA
3. Goldstein, H., Charles, P. P. & Safko J. L. (2001). *Classical mechanics* (3rd ed). Massachusetts: Addison Wesley Reading.

Suggested Readings:

1. Taylor, J. R. (2005). *Classical mechanics*. California: University Science Books.
2. Tom, W. B. K. (2005). *Classical dynamics* (5th ed). London: Imperial College Press.
3. Finn, J. M. (2010). *Classical dynamics*. Boston: Jones and Bartlett Publishers.

PHYS-6111

Electromagnetism-I

3(3-0)

Course Brief:

PHYS-6110 gives an insight of electromagnetism with emphasis on the following topics: Orthogonal coordinate systems, fundamental theorems, Electrostatics in free space, boundary-value problems, electrostatics inside matter and currents.

Course Learning Objectives:

The learning objectives for the students are to understand the laws of electrostatics, their mathematical forms, ideas contained in them, the logical steps of the arguments which leads to these equations and the ability to solve problems involving them.

Course Contents:

1. Differential calculus: gradient, divergence, curl
2. Integral calculus: gradient theorem, Green's theorem, Stokes' theorem
3. Orthogonal coordinate systems: cartesian, cylindrical and spherical coordinate systems
4. Electrostatics in free space: Coulomb's law for electric force, electric field and electric potential due to a single point charge, discrete charge distribution and continuous charge distributions
5. Gauss's law, divergence and curl of static electric field, electrostatic boundary conditions, electrostatic energy for discrete and continuous charge distributions, conductors
6. Capacitors: parallel-plate, cylindrical and spherical capacitors
7. Boundary-value problems: solutions of Laplace's equation in cartesian, cylindrical and spherical coordinates, method of images; other image problems
8. Electric field and electric potential of an electric dipole, multipole expansion of electric potential
9. Electrostatics inside matter: polarization; electric field and electric potential of a polarized object; bound charges, Gauss's law in the presence of dielectrics; boundary conditions on electric displacement; electrostatic energy in dielectrics, Electric susceptibility, permittivity, relative permittivity
10. Electric line, surface and volume currents, equation of continuity, magnetic force on line, surface and volume currents.

Recommended Texts:

1. Griffiths, D. J. (2007). *Introduction to electrodynamics* (4th ed.). New York: Prentice Hall.
2. Cheng, D. K. (2013). *Field and wave electromagnetics* (2nd ed.). New York: Pearson.

Suggested Readings:

1. Vanderlinde, J. (2005). *Classical electromagnetic theory* (2nd ed.). New York: Springer.
 2. Zahn, M. (2003). *Electromagnetic field theory: a problem solving approach* (1st ed.). Florida: Krieger Publishing Co.
- Fleisch, D. (2008). *A student's guide to Maxwell's equations* (1st ed.). Cambridge: Cambridge University Press.

PHYS-6112

Electronics

3(3-0)

Electronics is the application of devices controlling the flow of electrons. The nonlinear behavior of active components and their ability to control electron flows makes amplification of weak signals possible.

Course Learning Objectives:

Electronics is widely used in information processing, telecommunication, and signal processing. The ability of electronic devices to act as switches makes digital information processing possible. This course covers the basic concepts of Electronics which helps students to learn and understand.

Course Contents:

- 1 Semiconductor diode and application, semiconductor diode, characteristics curves
- 2 Dc & ac resistance, diode equivalent circuit, series and parallel diode configuration with dc load
- 3 Rectification, half and full wave rectifier circuit with and without filter, zener diode, led
- 4 bjt's: transistor and transistor operation, transistor configurations (cb, ce, cc)
- 5 Current amplification factors, load line and operating conditions
- 6 Dc biasing (voltage divider bias c-e amplifier), design of voltage divider bias c-e amplifier
- 7 negative feedback amplifiers, general characteristics of negative feedback amplifiers
- 8 Classification of negative feedback amplifiers, voltage series feedback amplifier. Integrated amplifier: the differential amplifier (modes of operation, common mode rejection ratio)
- 9 Operational amplifier and its parameters, op-amp configuration with negative feedback, op-amp applications (voltage summing, voltage buffer, voltage comparators)
- 10 Op-amp as differentiator and integrator oscillators: oscillator principles and conditions for oscillation, oscillator with lc feedback circuits
- 11 Transistor rc phase shift oscillator, crystal oscillators, ujt relaxation oscillator, multi vibrators, schmitt trigger
- 12 Field effect transistors: introduction of fets
- 13 Construction and basic operation jfet, characteristics and parameter of jfets, jfets biasing (voltage divider bias)
- 14 The metal oxide semiconductor fet (mosfet), mosfet parameters and characteristics, low and high frequency response of fet amplifiers.
- 15 Negative Feedback Amplifiers: Negative feedback amplifiers, General characteristics of Negative feedback amplifiers, Classification of negative feedback amplifiers, voltage series feedback amplifier.
- 16 Integrated amplifier: The Differential amplifier (modes of operation, common mode rejection ratio), Operational Amplifier and its parameters, Op-amp configuration with negative feedback ,Op-amp applications (voltage summing, voltage buffer, voltage comparators), Op- amp as differentiator and integrator.
- 17 Oscillators: Oscillator Principles and conditions for oscillation, Oscillator with LC feedback circuits, Transistor RC phase shift oscillator, Crystal oscillators, UJT relaxation oscillator, Multivibrators, Schmitt trigger.

Recommended Texts:

1. Boylestad, R. & Nashelsky, L. (2002). *Electronic devices and circuit theory*. New Jersey: Pearson Prentice Hall.
2. Floyd, T. L. (2007). *Principles of electric circuits*. New Jersey: Pearson Prentice Hall.

Suggested Readings:

1. Halliday, D., Resnick, R. & Walker, J. (2014). *Fundamental of physics* (10th ed.). New York: Wiley.
2. Young, H. D., Freedman, R. A. & Ford, A. L. (2019). *University physics* (15th ed.). New York: Pearson.
3. Beiser, A. (2003). *Concepts of modern physics* (6th ed.). New York: McGraw-Hill Education.

This course introduces the students to basic of electric circuits through a series of experiments. This includes the working principles of resistors, capacitors and inductors. Students learn different experimental techniques to determine the values of combination of different circuits. The course introduces students to the basic components of electronics: diodes, transistors, and operational amplifiers

Course Learning Objectives:

It covers the basic operation and some common applications. This laboratory course will help the students in getting familiarized with basic electrical measurement techniques, enhancing ability to apply electrical theory to practical problems, practice in recording and reporting technical information, familiarization with electrical safety requirement and also verification of some basic electric circuit theorems.

Course Contents:

- 1 . To construct from discrete components or, and, not circuits and verify their truth tables
- 2 To construct from discrete components nand, nor, exclusive or circuits and verify their truth tables
- 3 Design a fixed and self-bias and voltage divider bias transistor
- 4 To construct a single stage ce transistor voltage amplifier and study gain, input impedance, output impedance, and half power points by sine/square wave testing and effect of bias on the output and measurement of distortion
- 5 To construct and study the wave forms at the base and collector of the transistors of a free running a multivibrators
- 6 To construct and study of the height, duration and time period of the output pulses in a monostable and bistable multivibrators with reference to the input trigger
- 7 To study of rc integrators and differentiators
- 8 Design an inverting and non-inverting d.c. Amplifier, measurement of parameters of a given ic operational amplifier
- 9 Design and study the application of operational amplifier (current to voltage converter, instrumentation amplifier, buffer, voltage clamp, integrator and differentiator. low and high pass filters and half-wave rectifier)
- 10 To construct a phase shift or wein bridge oscillator and measure its frequency by 741,555 timer

Recommended Texts:

1. . Robert, L. B. & Nashelsky, L. (2005). *Electronic devices and circuit theory* (9th ed.). New Jersey: Prentice Hall.
2. Higgins, R. J. (1974). *Experimental electronics* (4th ed.). New York: McGraw-Hill Education.

Suggested Readings:

1. Mitchel, E. S. (2003). *Grob's basic electronics* (13th ed.). New York: McGraw-Hill Education.
2. Thomas, L. F. (1981). *Principles of electric circuits* (31st ed.). OH: Charles E. Merrill Publishing Co


 Chairman
 Department of Physics
 University of Georgia

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URCG-5129

Model Course Outline for the Course Understanding of Quran – I

Course Title: Understanding of Quran – I

Course Book: Muallim ul Quran (Volume 1, 2 & 3) by Dr Ubaid ur Rahman

Credit Hours: 1 (0-1)

Contact Hours: 3 per week

Weeks: 15-16 (45-48 hours)

Course Learning Outcomes:

By the end of this course, students will be able to:

1. Develop the ability to understand basic words of the Quran, phrases and sentences that do not contain verbs (unit 1 to 5 of Muallim ul Quran Book) and then sentences having present tense (first half of unit 6 of Muallim ul Quran Book).
2. Acquire a strong foundation for understanding long verses of the Quran with clarity.
3. Comprehend Quranic vocabulary, particles (operative & non operative particles), compounds (Adjective & Possessive compound), pronouns (singular & plural) and types of plural through hundreds of Quranic sentences.
4. Recognize and understand different styles of Quranic sentences, including nominal sentence, emphatic sentence, double emphatic sentence, negative sentence, interrogative sentence, oath-based sentences.
5. Strengthen understanding of fundamental Quranic linguistic styles, expressions and idioms.
6. Understand at least 30 to 40 % of each page of the holy Quran.

Provision of material, content and books:

- Paper book: All volumes are available in printed book form.
- Tutorial videos: Teaching video of each lesson available on YouTube.
- Confirmation Videos: A complete series of confirmation videos of all lessons is available in which the student can confirm his answers.
- A flipbook: A flipbook edition is also accessible.
- Helping material: Helping material for the teachers like quizzes, question papers and images is available on website.

Handwritten signature and stamp:
 Dr. Ubaid ur Rahman
 Head of Department
 Department of Islamic Studies
 University of the Punjab
 Lahore

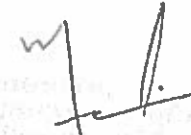
Course Outline:

Weeks	Lectures (1.5 hrs)	Units	Lessons	Assignments/Home Task	Linguistic Rules
1.	1.	1	1-6	Writing the meaning of Quranic words Lesson 1-8	Proper Noun Masculine & Feminine
	2.	1	9-14	Writing the meaning of Quranic words 9-14	Two kinds of plural Concept of (ر) "And" Common Noun
2.	1.	1	15-17	Writing the meaning of Quranic words, phrases & translation of Sentences 15-17	Demonstrative Noun (This & That for Masculine (هذه- هذا) Demonstrative Noun (This & That for Feminine) (ذلك- تلك)
	2.	1	18-19 & Revision (Unit 1)	Writing the meaning of Quranic words, phrases & translation of Sentences 17-19 Quiz	Laam for emphasis (لام التأكيد) Superlative Degree like أكبر Revision of all Quranic Sentences
3.	1.	Unit 2	1-3	Writing the meaning of Quranic words, phrases & translation of Sentences 1-3	Emphatic Particle (لن) Preposition "For" (للام) Preposition (في)
	2.	2	4-6	Writing the meaning of Quranic words, phrases & translation of Sentences 4-6	Preposition (على- من- إلى)
4.	1.	2	7-9	Writing the meaning of Quranic words & translation of Sentences 7-9	Preposition (إلى) Absolute Negation Particle Exceptive Particle (لا للتانيه) (إلا) (ما التانيه) (للجنس)
	2.	2	10-13 & Revision (Unit 2)	Writing the meaning of Quranic words, phrases & translation of Sentences 10-13 Quiz	Subordinating Conjunction (أن), Was (كان), Vocative Particle (حرف النداء)

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5.	1.	Unit 3	1-2	Writing the meaning of Quranic phrases 1-2	Quranic Adjective Compounds (صفة وموصوف) (صفتة وموصوفت)
	2.	3	3-5	Writing the meaning of Quranic phrases & translation of sentences 3-5	Quranic Possessive Construction (مضاف ومضاف إليه)
6.	1.	3	6-7	Writing the meaning of Quranic phrase translation of sentences 6-7	Quranic Possessive Construction (مضاف ومضاف إليه)
	2.	3	8-10 & Revision (Unit 3)	Writing the meaning of Quranic phrase & translation of sentences 8-10 Quiz	Active Participle (اسم التفاعل), Passive Participle (اسم المفعول), Dual (مثنى)
7.	1.	Unit 4	1-2	Writing the meaning of Quranic phrase & translation of sentences 1-2	Personal Pronoun He (هو المتصل), Possessive Pronoun His (المتصل)
	2.	4	3-4	Writing the meaning of Quranic phrase & translation of sentences 3-4	Possessive Pronoun with prepositions like في بيته, Pronoun "His" with prepositions like له، منه، فيه
8.	1.	4	5-8	Writing the meaning of Quranic sentences 5-8	Personal Pronoun You (انت المتصل), Possessive Pronoun Your (ك المتصل), Possessive Pronoun with prepositions like في بيتك, Pronoun "your" with prepositions like لله ملك، فيك
	2.	Mid-Term			


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9.	1.	4	9-12	Writing the meaning of Quranic phrases & sentences 9-12	Personal Pronoun She (هي المنفصل) Possessive Pronoun Her (ها المتصل) Possessive Pronoun with prepositions like لي بيتها Pronoun "Her" with prepositions like لها
	2.	4	13-16	Writing the meaning of Quranic phrases & sentences 13-16	Personal Pronoun I (انا المنفصل) Possessive Pronoun Her (ي المتصل) Possessive Pronoun with prepositions like لي بيتي Pronoun "My" with prepositions like لي
10.	1	4	17 & Revision Unit 4	Revision of all Quranic sentences of Unit 4 Quiz	Adverb (حال)
	2.	Unit 5	1-2	Writing the meaning of Quranic phrases & sentences 1-2	Masculine Plural جمع المذكر السالم و جمع المذكر السالم المسبوق بحرف الجر
11.	1.	5	3-4	Writing the meaning of Quranic phrases & sentences 3-4	Possessive Construction with Plurals جمع المذكر السالم المسبوق بالإضافة
	2.	5	5-6	Writing the meaning of Quranic phrases, sentences & verses 5-6	Personal Pronoun They (هم المنفصل) Possessive Pronoun Their (هم المتصل)
12.	1.	5	7-8	Writing the meaning of Quranic phrases, sentences & verses 7-8	Possessive Pronoun with prepositions like لي بيتهم Pronoun "Their" with prepositions like لهم
	2.	5	9-11	Writing the meaning of Quranic phrases, sentences & verses 9-11	Personal Pronoun You (انتم المنفصل) Possessive Pronoun Your (كم المتصل) Possessive Pronoun with prepositions

7/1

12

3.	1.	5	12-14	Writing the meaning of Quranic phrases & sentences & verses 12-14	like في بيتكم Pronoun "Your" with prepositions like لكم Personal Pronoun We (نحن المتصل) Possessive Pronoun Our نا (المتصل)
	2.	5	15-16	Writing the meaning of Quranic sentences & verses 15-16	Possessive Pronoun with prepositions like في بيتنا Pronoun "Our" with prepositions like لنا
4.	1.	5	17-18	Writing the meaning of Quranic sentences & Verses 17-18	Demonstrative Pronoun These, Those (هؤلاء - أولئك)
	2.	5	19-23	Writing the meaning of Quranic sentences & Verses 19-23	ما / إله / إن / إله / إله / ليس ، ما ، (/ أم ، أن ، ول ، كان) (آله ، ليس ، اليوم ، يومئذ سبحان ، ما بينهما قل ، إذن ، بنس ، نعم ، كلا ، ما أدراك ، حسب ، أعلم به ، مصير ، مرجع ، ديلا (تمييز))
5.	1.	5	Revision Unit 5	Quiz	
	2.	5	1-3 (till Page 16)	Writing the meaning of Quranic Verbs & Translation of Quranic Sentences & Verses (1-3)	Introduction of Present Tense (فعل مضارع) & Verbal Sentence (جملة فعلية) Present Tense الفعل المضارع صيغة المفرد يعلم
6.	1.	6	3 (From Page 17) & 4-5	Translation of Quranic Sentences & Verses 3-5	Present Tense الفعل المضارع صيغة المفرد يعلم
	2.	6	6	Translation of Quranic Sentences & Verses	Present Tense الفعل المضارع صيغة الجمع يعلمون

OR


 Chair in
 Department of English
 University of Sargodha


Ethics-I

URCG-5131

1 (0-1)

1-Course Description

The Ethics-I course is designed to provide students with a comprehensive understanding of ethical principles, practices, and theories in various societal contexts. Throughout this degree program, students will explore the complexities of ethical theories of semitic and non-semitic religions along with decision-making and develop critical thinking skills to navigate moral dilemmas. This course will also enable the students to interact with others religious identities with humanistic, inclusive and holistic approach

2- Learning Objectives

This course aims to:

1. Introduce students to the fundamental concepts, scope, and importance of ethics.
2. Explore the relationship between law, morality, and social values.
3. Develop a clear understanding of virtuous and immoral ethics and their impact on individual and collective life.
4. Study the role of major religious figures in the moral development of human society and enable students to apply ethical principles for personal development, conflict resolution, and social harmony.

3- Learning Outcomes

By the end of the course, students will be able to:

1. Students will be able to identify and analyze major ethical theories, values, and their scope in social and individual life.
2. Differentiate between law and ethics, and analyze their interrelationship.
3. Identify types of virtuous and immoral ethics and assess their social impacts.
4. Examine the ethical teachings of major religions and their relevance in contemporary society.
5. Apply ethical principles to address modern challenges in personal and professional life.

4-Course Structure

1. Interactive lectures, Group discussions and debates
2. Reflection papers and presentations
3. Assignments and Quiz

Course Contents**Unit 1: Introduction and Fundamentals of Ethics**

1. Literal and terminological definition of ethics
2. Literal and terminological definition of values
3. Relationship between law and ethics
4. Need, importance, and scope of ethics

Unit 2: Types of Ethics and Their Impact on Society

- Virtuous ethics: concept, types, benefits, and outcomes
- Immoral ethics: concept, types, and harms
- Role of ethics in social refinement and establishment of peace

Unit 3: Virtuous Ethics (Akhlaq-e-Hasanah)

- Concept, need, and importance of virtuous ethics
- Scope of virtuous ethics in the light of religions
- Major virtues in revealed and non-revealed religions
- Impact of virtuous ethics on individual and collective life

Unit 4: Immoral Ethics (Akhlaq-e-Razilah)

- Concept of immoral ethics
- Social problems caused by immoral ethics
- Practical consequences of immoral ethics
- Major vices in revealed and non-revealed religions

Unit 5: Role of World Religious Figures in Moral Development

- Prophet Moses (AS): introduction, miracles, and role in moral refinement
- Prophet Jesus (AS): introduction, miracles, and role in moral refinement
- Prophet Muhammad (ﷺ): introduction, miracles, and role in moral refinement

Textbook

1. Izutsu, T. (2002). *Ethico-Religious Concepts in the Qur'an*. McGill-Queen's University Press.

Suggested Readings

1. Gert, B. (2005). *Morality: Its Nature and Justification*. Oxford University Press.
2. MacIntyre, A. (2007). *After Virtue: A Study in Moral Theory*. University of Notre Dame Press.
3. Al-Ghazali, Abu Hamid (2001). *The Alchemy of Happiness*. Islamic Texts Society.
4. Nasr, S. H. (1994). *The Heart of Islam: Enduring Values for Humanity*. Harper One.
5. Beauchamp, T. L., & Childress, J. F. (2019). *Principles of Biomedical Ethics*. Oxford University Press.
6. Hasan, Z. (2010). *Ethics in Islam: Key Concepts and Contemporary Challenges*. Islamic Research Institute.

Semester-VI

PHYS-6114

Methods of Mathematical Physics-II

3(3-0)

Course Brief:

This course provides a wide range of analytical mathematical techniques essential to the solution of advanced problems in physics. The main objective is to develop intuition towards formulating physical phenomena in mathematical language that are most commonly used to solve problems in physics. This course has an in-depth understanding of the basics of special functions and their applications to problem solving techniques.

Course Learning Objectives:

The course learning objectives are to develop mathematical skills in students to solve problems (ordinary differential equations and partial differential equations) in quantum mechanics, solid state physics and other main course of physics by using Fourier series, Fourier integral, Fourier Transform and Laplace transform.

Course Contents:

- 1 Legendre equation Legendre Polynomials: Generating Functions, Recurrence Relations, Orthogonality, Associated Legendre equation, Associated Legendre Functions its orthogonality, Spherical Harmonics, Legendre Function of the second kind.
- 2 Hermite equation and Hermite polynomials (Generating function, orthogonality, recurrence relations)
- 3 Laguerre equation and Laguerre Functions (Generating function, orthogonality, recurrence relations)
- 4 Associated Laguerre Functions
- 5 Fourier Series: Definition and general properties of Fourier series, Uses and Applications of Fourier Series.
- 6 Fourier series of any period
- 7 Cosine and sine Fourier series
- 8 Complex form of Fourier series
- 9 Fourier integral
- 10 Gibbs phenomenon
- 11 Integral transforms
- 12 Fourier transforms and inversion theorem
- 13 Discrete Fourier transform
- 14 Fourier transforms of derivatives
- 15 Convolution theorem.
- 16 Laplace transform and its application.
- 17 Inverse Laplace transform.
- 18 Laplace transforms by derivatives
- 19 Solution of differential equation using Laplace transform (Initial valued problems)

Recommended Texts:

1. Arfken, G. B., Weber, H. J. & Harris, F. E. (2011). *Mathematical methods for physicists* (7th ed.). New York : Elsevier Science.
2. Kreyszig, E. (2011). *Advanced engineering mathematics* (10th ed.). New York: Wiley.

Suggested Readings:

1. Spiegel, M. R., Lipschutz, S., Schiller, J. J. & Spellman, D. (2009). *Schaum's outline of complex variables* (2nd ed.). New York: McGraw Hill Professional.
2. Wong, C. W. (2013). *Introduction to mathematical physics* (2nd ed.). Oxford: Oxford University Press.
- Kakani, S. L. & Hemrajani, C. (2010). *Mathematical physics* (2nd ed.). New Delhi: CBS Publishers & Distributors.

The aim of this course is to continue, merge and extend the studies of Classical Mechanics I PHYS-302 in previous semester. Its ideas also link with other courses like quantum mechanics and condensed matter. The fundamental goal of this course is to create understanding in students to classical mechanics and its applications. This course provides the students the up-to-date treatment of classical mechanical systems and serves as basics and pre-requisite of Quantum Mechanics so that students face least difficulty in entering from classical Physics to Quantum mechanics. The purpose of the course is to make the students capable in formulating and solving physics problems.

Course Learning Objectives:

Upon successful completion of the course, the student will be able:

- 1- To develop a knowledge of the calculus of variations, central force motion and motion of planets.
- 2- To deal with the system of particles and related phenomenon.
- 3- To write the equations of motion for complicated mechanical systems using the Lagrange's and Hamilton's equations of motion.
- 4- To develop problem solving approach and critical thinking, Students will be able to solve problems in applied physics.
- 5- To study advance fields of Physics like quantum mechanics and field theory on the basis of Lagrangian and Hamiltonian technique.

Course Contents:

- 1 Some methods in the calculus of variations
- 2 Euler's equation, "first and second form" of Euler's equation
- 3 Kinematics of system of particles
- 4 Collision between particles, center of mass and lab co-ordinate system, elastic collision in lab and cm coordinate system
- 5 Scattering by central force field, Rutherford's scattering formula
- 6 Rocket motion
- 7 Limitations of Newtonian mechanics, generalized co-ordinates and constraints, virtual displacement and virtual work
- 8 D' Alembert's principle and Lagrange 's equation
- 9 Lagrange 's equation of motion and its applications
- 10 Hamilton's principle and Lagrange's equation
- 11 Hamiltonian of dynamical system, Hamilton's canonical equations
- 12 Poisson bracket and their properties
- 13 Central force motion, Two body problem and reduced mass
- 14 General solution of problems of motion in central force field
- 15 Inverse square law of force, Kepler's laws of planetary motion
- 16 Orbital dynamics, orbits in central field and stability of circular orbits
- 17 Dynamics of rigid body, Inertia tensor and principal axes of inertia, Moment of inertia for different body coordinate system,
- 18 Eulerian angles and Euler's equation of motion for a rigid body, Motion of a symmetric top.

Recommended Texts:

1. Thornton, S. T. & Marion, J. B. (2012). *Classical dynamics of particles and systems* (5th ed.). New York: Thomson Brooks/Cole
2. Tai L. Chow. (2010). *Classical mechanics*. (2nd ed). Taylor and Francis. California USA
3. Goldstein, H., Charles, P. P. & Safko J. L. (2001). *Classical mechanics*. (3rd ed). Massachusetts: Addison Wesley Reading.

Suggested Readings:

1. Taylor, J. R. (2005). *Classical mechanics*. California: University Science Books.
2. Tom W. B. K. (2005). *Classical dynamics* (5th Ed.). London: Imperial College Press.
3. Finn J. M. (2010). *Classical dynamics*. Boston: Jones and Bartlett Publishers..

PHYS-6116

Electromagnetism-II

3(3-0)

Course Brief:

PHYS-6115 gives an insight of electromagnetism with emphasis on the following topics: Magnetostatics in free space, classification of fields, magnetostatics inside matter, electromagnetic induction, Maxwell's equations in free space and inside matter, and electromagnetic waves in free space and inside matter.

Course Learning Objectives:

The learning objectives are to understand the laws of magnetostatics, their mathematical forms, ideas contained in them, the logical steps of the arguments which leads to these equations and the ability to solve problems involving them. For the students to be aware of deep physical meanings for the existence of electromagnetic waves as a consequence of Maxwell's equations is also of particular importance.

Course Contents:

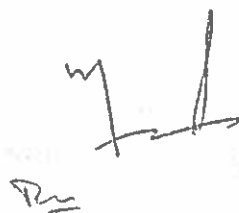
1. Magnetostatics in free space: Biot-Savart law for magnetic force, magnetic field and magnetic vector potential due to line, surface and volume currents, divergence and curl of static magnetic field, classification of Fields
2. Solutions of Laplace's vector equation and poisson's vector equation, Ampere's law, magnetostatic boundary conditions
3. Magnetic field and magnetic vector potential of a magnetic dipole, multipole expansion of magnetic vector potential
4. Magnetostatics inside matter: magnetization, magnetic field and magnetic vector potential of a magnetized object, bound currents
5. Ampere's law inside matter; boundary conditions on magnetic displacement, paramagnetic, diamagnetic and ferromagnetic materials
6. Electrodynamics: ohm's law, electromotive force
7. Faraday's law, differential and integral forms and its uses/applications, Lenz's law
8. Inductors, mutual and self inductance, energy stored in magnetic field, magnetic energy for line, surface and volume currents
9. Maxwell's equations in free space for static and dynamic cases, displacement current, Maxwell's equations inside matter for static and dynamic cases, polarization current
10. Poynting's theorem, Electromagnetic waves in free space and inside matter

Recommended Texts:

1. Griffiths. D. J. (2007). *Introduction to electrodynamics* (4th ed.). New York: Prentice Hall.
2. Cheng, D. K. (2013). *Field and wave electromagnetics* (2nd ed.). New York: Pearson.

Suggested Readings:

1. Vanderlinde, J. (2005). *Classical electromagnetic theory* (2nd ed.). New York: Springer.
2. Zahn, M. (2003). *Electromagnetic field theory: a problem solving approach* (1st ed.). Florida: Krieger Publishing Co.
3. Fleisch, D. (2008). *A student's guide to Maxwell's equations* (1st ed.). Cambridge: Cambridge University Press.



Quantum mechanics (QM) is important because it plays a fundamental role in explaining how the world works. Physicists often says QM governs the behavior of microscopic systems when in fact it governs the behavior of all physical systems, regardless of their size. It tells us a lot about the structure of reality. In this course, we review the fundamental ideas of QM, introduce the path integral for a non-relativistic point particle.

Course Learning Objectives:

The student will gain the knowledge about general experience with non-relativistic quantum mechanics that is useful for further studies in theoretical and experimental physics as well as nanotechnology for device applications. Moreover, they will acquire the knowledge about fundamental quantum mechanical processes in nature and experience using mathematical tools to construct appropriate models for various practical purposes.

Course Contents:

1. Review of Concepts of Classical Mechanics and Historical Review (Experiments and Theories).
2. Wave Aspects of Particles, Hilbert Space, and Wave Functions.
3. The linear vector space, Hilbert space, Dimensions, and basis of a vector space.
4. Square integrable wave functions, Dirac notation, and Operators.
5. The state of a system and Observables, Measurement in Quantum Mechanics.
6. Time evolution operator, Stationary states, Time independent potentials.
7. Time evolution of expectation values, Symmetries, and Conservation Laws.
8. Symmetric potentials, parity, and Properties of one dimensional motion.
9. The free particle, step potential, and potential barrier and well.
10. The finite and infinite square well potential.

Recommended Texts:

1. Zettili, N. (2009). *Quantum mechanics: concepts and applications* (2nd ed.). New York: John Wiley & Sons.
2. Liboff, R. L. (2002). *Introductory quantum mechanics* (4th ed.). New York: Addison Wesley Publishing Company.

Suggested Readings:

1. Townsend, J. S. (2012). *A modern approach to quantum mechanics* (2nd ed.). New York: University Science Books.
2. Robinett, R. W. (2006). *Quantum mechanics, classical results, modern systems and visualized examples* (2nd ed.). Oxford: Oxford University Press.
3. Griffiths D. J. (2018). *Introduction to quantum mechanics* (3rd ed.). Cambridge: Cambridge University Press.

This course offers an introductory exploration of the theoretical framework underlying solid state materials, with a particular emphasis on crystalline materials. The curriculum covers fundamental principles concerning crystal structure, interatomic bonding, x-ray diffraction, and lattice dynamics. Students will acquire the knowledge and skills necessary to effectively use these principles in order to fully understand the many characteristics shown by crystalline materials, including but not limited to their electrical, optical, and mechanical properties.

Course Learning Objectives:

Define "lattice", "unit cell", and "crystal system" in relation to crystal structure. Calculate crystal density from lattice structure and atomic composition. Explain the kinds of interatomic bonding (ionic,

covalent, metallic, and van der Waals). Diatomic molecule bond energy calculation. Explain how interatomic bonding influences material characteristics. Explain the concepts of X-ray diffraction. Determine a material's crystal structure through x-ray diffraction. In lattice dynamics, define "phonon" and "lattice heat capacity". Calculate a material's lattice heat capacity using classical or quantum physics.

Course Contents:

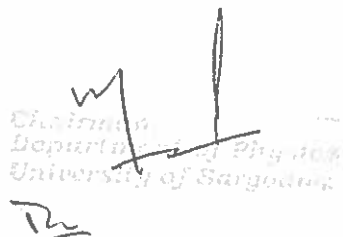
- 1 Crystal structure, periodic arrays of atoms, fundamental types of lattices
- 2 Index system for crystal planes, simple crystal structures,
- 3 Direct imaging of atomic structure, non-ideal crystal structures,
- 4 Reciprocal lattice, methods of x-ray diffraction by the crystals, scattered wave amplitude,
- 5 Brillouin zones, Fourier analysis of the basis, quasi crystals,
- 6 Crystal binding and elastic constants, crystals of inert gases, ionic crystals,
- 7 Covalent crystals, metals, hydrogen bonds, analysis of elastic strains, elastic compliance and stiffness constants, elastic waves in cubic crystals,
- 8 Vibrations of crystals with monatomic basis, two atoms per primitive basis,
- 9 Quantization of elastic waves, phonon momentum, inelastic scattering by phonons, Classical and quantum theories of lattice heat capacity,
- 10 Free electron model, Free electron gas in one dimension,
- 11 Finite temperature: the Fermi-Dirac distribution, Free electron gas in three dimensions,
- 12 K-Space, Fermi energy, Fermi momentum, and Fermi temperature,
- 13 Density of states, heat capacity of the electron gas, qualitative and quantitative solution to the problem of electronic
- 14 Heat capacity of free electron gas, Sommerfeld Model

Recommended Texts

1. Kittel, C. (2005). *Introduction to solid state physics* (8th ed.). New Jersey: Wiley
2. Wahab, M. A. (2017). *Solid states physics: structure and properties of materials* (3rd ed.). Oxford: Alpha Science International.

Suggested Readings

1. Szwachi, N. G. & Szwacka, T. (2016). *Basic elements of crystallography* (2nd ed.). Singapore: Pan Stanford Publishing.
2. Simon, S. H. (2013). *The oxford solid state basics* (1st ed.). Oxford: Oxford University Press.
3. Blakemore, J. S. (2012). *Solid state physics* (2nd ed.). Cambridge: Cambridge University Press.
- Kakani, S. L. & Hemrajani, C. (2010). *Mathematical physics* (2nd ed.). New Delhi: CBS Publishers.


Chairman
Department of Physics
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The purpose of this course is to translate the microscopic (quantum) world where the laws of nature are written to the everyday macroscopic (classical) world that we're familiar with, covering both classical and quantum Statistical Mechanics. Statistical Mechanics is a probabilistic approach to equilibrium properties of large numbers of degrees of freedom. It demonstrates the firm physical and statistical basis of thermodynamics by showing how the properties of macroscopic systems are direct consequences of the behaviors of their elementary constituents.

Course Learning objectives:

After the successful completion of this course, student will be in apposition to apply classical and quantum mechanical rules to large assemblies of microscopic entities. Students will be able to describe the vibrational motions of ions, atoms and molecules within the crystals. They will be skilled in calculating the heat capacities and entropies changes within the systems.

Contents:

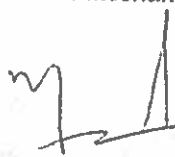
- 1 Review of thermodynamics: mathematical formulation of first and second law of thermodynamics
- 2 Maxwell's relation, reduction of derivatives, general conditions of equilibrium
- 3 Partition function: partition function, relations of partition function with thermodynamical variables, examples (collection of simple harmonic oscillators, half spin paramagnet)
- 4 Basic principles of statistical mechanics: microscopic and macroscopic states, phase space, ensembles, Liouville theorem
- 5 Formation of micro-canonical, canonical and grand canonical partition function, Maxwell distribution of molecular speed
- 6 Probability of the particle in quantum state, density of states in k-space, single particle density of states in energy
- 7 Maxwell-Boltzmann distribution function, validity of Maxwell-Boltzmann statistics, evaluation of constants α and β , Maxwell speed distribution function
- 8 Theory of ideal Fermi system: Fermi-Dirac distribution function, examples of the Fermi system (free electron theory of metals, electrons in stars, electrons in white dwarf stars)
- 9 Theory of Bose system: Bose-Einstein distribution function, black body radiation, the photon gas, ideal Bose gas model of liquid helium, Einstein's model of vibration in a solids, Debye's model of vibration in a solids, advanced topics: fluctuations, Bose-Einstein condensation
- 10 Introduction to density matrix approach.

Recommended Books:

1. Reif, F. (2009). *Fundamentals of statistical and thermal physics*. New York: McGraw Hill.
2. Garg, S. C., Bansal, R.M. & Ghosh, C.K. (2012). *Thermal physics* (2nd ed.). India: McGraw Hill.
3. Kersan Huang, Introduction to Statistical Physics, 2nd Edition
4. Blundell, S.J; Blundell, K.M; Concepts in thermal Physics, 2nd edition, Oxford University press (2009).
5. Rief, F; Statistical Physics, Barkely Physics Course Vol. 5 Mcgraw-Hill Book Company 1967.

Suggested Readings:

1. Agarwal, B. K. & Melvin, E. (2012). *Statistical mechanics* (3rd ed.). New Delhi: New Age International.
2. Pathria, R. K. (2011). *Statistical mechanics*. UK: Elsevier Ltd.
3. Sinha, S. K. (2007). *Introduction to statistical mechanics*. Oxford: Alpha Science International.


 P₂

Atomic and Molecular Physics is a field of physics that involves investigation of the structures of atoms and molecules, their energy states, and their interactions with other particles and electromagnetic radiation. In this field of physics, atoms are studied as isolated systems made up of nuclei and electrons. Its primary concern is related to the arrangement of electrons around the nucleus and the processes by which these arrangements change. The aim of this course is to develop an understanding of the physics of atoms, atomic structure and molecular energy levels spectra.

Course Learning objectives:

After completion of this course, students should be able to elaborate basic concepts, interpret the fundamental principles of plasma physics based on experimental as well mathematical foundations. This course provides a platform for advance studies in the field of plasma physics.

Contents:

- 1 Atomic structure, the Thomson model, the Rutherford model, alpha-particle scattering, the Rutherford scattering formula.
- 2 The Thomson model, The Rutherford model, Alpha-Particle Scattering.
- 3 Electron orbits, Sommerfeld model.
- 4 Atomic Spectra of hydrogen atom, Nuclear Motion and Reduced Mass.
- 5 The Correspondence principle.
- 6 The Frank-Hertz experiment.
- 7 Quantum Theory of the Hydrogen Atom, the Schrödinger equation, solution of the angular equation, solution of the radial equation, Quantum numbers, Total Quantum numbers, Orbital Quantum number, Magnetic Quantum Number.
- 8 Atoms in external fields, Space quantization, Magnetic moment, and Bohr Magneton
- 9 The Zeeman effect (normal and anomalous Zeeman effects).
- 10 Fine structure of hydrogen, parity, selection rules, transitions between fine-structure levels.
- 11 Stern-Gerlach Experiment
- 12 Spin-orbit interaction
- 13 Shells and sub shell's structure and the periodic table
- 14 Electron configuration in many electron-atoms, Exclusion principle,
- 15 Hund's rules, Coupling of angular momenta, LS-coupling, jj-coupling.
- 16 Origin of Spectral lines Two-electron Spectra, One electron Spectra, Selection Rules (LS-coupling)
- 17 Relative intensities in a multiplet, X-ray spectra.
- 18 Paschen-Back effect, Stark effect.
- 19 Introduction of Molecular Physics
- 20 Molecular formation
- 21 Theories of bonding
- 22 The H₂ Molecule
- 23 Molecular orbits
- 24 Molecular spectra (diatomic molecules)
- 25 Dissociation and Pre-disassociation energy

Recommended Books:

1. Foot, C. (2005). *Atomic physics* (1st ed.). New York: Oxford University Press.
2. Bransden, B. H., Joachian, C. J. & Plivier, T. J. (2003). *Physics of atoms and molecules*(2nd ed.). England: Person Education.

Suggested Readings:

1. Krane, K. S. (2019). *Modern physics* (4th ed.). New York: John Wiley & Sons.

2. White, H. E. (2016). *Introduction to atomic spectra* (1st ed.). India: McGraw-Hill.
3. Haken, H. & Wolf, H. C. (2012). *The physics of atoms and quanta: Introduction to experiments and theory*: Germany: Springer.
4. Thorne, A. P. (2012). *Spectro physics*. New York: Chapman & Hall.

PHYS-6122

Plasma Physics

3(3-0)

This is a calculus-based introductory course on plasma physics with maximum emphasis on conceptual understanding, mathematical formulation, interpretation of the fundamental principles of plasma physics and application of the acquired knowledge for solving problems. In this course, students will learn about plasmas, the fourth state of matter. The aim of this course is to describe, in words, the ways in which various concepts in plasma physics come into play in particular situations and discusses the applications and properties of human-made and naturally occurring plasmas.

Course Learning objectives:

After completion of this course, students should be able to elaborate basic concepts, interpret the fundamental principles of plasma physics based on experimental as well mathematical foundations. This course provides a platform for advance studies in the field of plasma physics.

Contents:

- 1 Introduction to plasmas, how plasmas are produced, occurrence of plasma in nature, concept of temperature, Debye shielding, plasma frequency, plasma parameter, criteria for plasma, applications of plasma physics
- 2 Motion of a charged particle in a static uniform electric and magnetic fields and in the presence of perpendicular electric and magnetic fields, gravitational drift, charge particle motion in nonuniform electric and magnetic fields, gradient drift, curvature drift, magnetic mirror
- 3 Time varying electric field, polarization drift, time varying magnetic field, adiabatic invariants
- 4 Fluid description of plasma, continuity equation, momentum balance equation, equation of state, and two-fluid equations, fluid drift perpendicular to magnetic field, fluid drift parallel to magnetic field, the plasma approximation
- 5 Waves in cold plasma, Fourier representation of waves, group velocity, plasma oscillations, electron and ion plasma waves, sound waves, ion waves, validity of plasma approximation, comparison of electron and ion waves
- 6 Electrostatic electron waves perpendicular to magnetic field, upper-hybrid frequency, electrostatic ion waves perpendicular to magnetic field, lower-hybrid frequency.
- 7 Electromagnetic waves in un-magnetized and magnetized plasmas, cutoffs and resonances, experimental consequences, hydromagnetic waves, magnetosonic waves

Recommended Books:

1. Chen, F. F. (2016). *Introduction to plasma physics and controlled fusion* (3rd ed.). New York: Springer.
2. Bittencourt, J. A. (2004). *Fundamentals of plasma physics* (3rd ed.). New York: Springer.

Suggested Readings:

1. Bellan, P. M. (2006). *Fundamentals of plasma physics* (1st ed.). Cambridge: Cambridge University Press.
2. Goldston, R. J. (2019). *Introduction to plasma physics*. Bristol: IOP Publishing.
3. Dendy, R. O. (1993). *Plasma physics: an introductory course*. Cambridge: Cambridge University Press.

PHYS-6123

Quantum Mechanics-II

3(3-0)

Quantum physics is arguably the greatest intellectual triumph in the history of human civilization, but to most people it seems like it's too remote and abstract to matter. This is largely a self-inflicted wound on the part of physicists and pop-science writers: when we talk about quantum physics, we usually emphasize the weird and counter-intuitive phenomena but it can be hard to see any connection between these phenomena

and everyday life. This course examines the fundamental concepts and techniques of quantum mechanics. Furthermore, it is used to derive time-dependent perturbation theory and the Born series for non-relativistic scattering.

Course Learning Objectives:

Students will develop a self-critical perspective on the theoretical techniques to solve the problems. Rather the task is to develop reflective and critical skills for thinking about creative solutions to for further higher studies and applications. Students will also gain the competence as they are able to apply non-relativistic quantum mechanics to microscopic fields such as solid state physics and nanotechnology.

Course Contents:

1. Orbital angular momentum, eigenvalues, and eigenfunctions of L^2 and L_z .
2. Matrix representation of angular Momentum operators and Schrödinger Equation in Three Dimensions.
3. 3D problems in Cartesian and Spherical coordinates.
4. Time independent and dependent perturbation theory for non-degenerate and degenerate levels.
5. Variational method, WKB approximation, and Time dependent perturbation theory.
6. Identical Particles, Second Quantization, Many Particles Systems, and Systems of Identical Particles.
7. Pauli Exclusion Principle, Theory of Scattering, and the Interaction of quantum systems with radiation.
8. Classical Treatment of Incident Radiation and Quantization of the electromagnetic field.
9. Transition Rates for Absorption and Emission of Radiation.
10. Transition Rates within the Dipole and the Electric Dipole Selection Rules.

Recommended Texts:

1. Zettili, N. (2009). *Quantum mechanics: concepts and applications* (2nd ed.). New York: John Wiley & Sons.
2. Liboff, R. L. (2002). *Introductory quantum mechanics*(4th ed.). New York: Addison Wesley Publishing Company.

Suggested Readings:

1. Townsend, J. S. (2012). *A modern approach to quantum mechanics* (2nd ed.). New York: University Science Books.
2. Robinett, R. W. (2006). *Quantum mechanics, classical results, modern systems and visualized examples* (2nd ed.). Oxford: Oxford University Press.
3. Griffiths D. J. (2018). *Introduction to quantum mechanics* (3rd ed.). Cambridge: Cambridge University Press.

PHYS-6124

Solid State Physics-II

3(3-0)

This course introduces solid state physics fundamentals. Quantum mechanics, crystallography, and solid electrical structure will dominate this course. Crystal structure and lattice vibrations are the focus of this dispute. A solid's electrical band structure shows its electron energy levels. The belief is the foundation of condensed matter research due of its relevance. Semiconductors are electrically in between conductors and insulators. Certain materials attract or repel due to magnetism. Physics defines solids by their optical characteristics, which explain how they behave with light. Some materials exhibit superconductivity at low temperatures.

Course Learning Objectives:

Quantum theory, crystallography, and solids are good venues to begin. Investigate the complicated movement of charged particles within solids. Study the ideas behind the formation of electronic bands and the behavior of electrons at different energy levels. The effects of external fields on charge carriers must be explained. This essay aims to provide a justification for the unique characteristics and

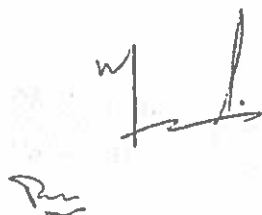
significance of semiconductors in the field of electronics. What is the historical background of the discovery of magnetism? The phenomenon of superconductivity has been studied both theoretically and experimentally.

Course Contents:

- 1 Effect of temperature on the Fermi-Dirac distribution, free electron gas in three dimensions, heat capacity of the electron gas,
- 2 Experimental electrical resistivity of metals, motion in magnetic fields, Hall effect, Magneto resistance, ratio of thermal to electrical conductivity.
- 3 Energy Bands: Nearly free electron model, origin of the energy gap, magnitude of the energy gap
- 4 Bloch functions, wave equation of an electron in a periodic potential
- 5 Periodic & extended zone schemes, motion of electrons in a periodic potential
- 6 Kronig-Penney model, calculation of band structure
- 7 Crystal momentum of an electron, solution of the central equation, empty lattice approximation,
- 8 Approximate solution near a zone boundary, number of orbital in a band, metals and insulators.
- 9 Homogeneous Semiconductors: Band gap, equation of motion, effective mass, physical
- 10 Interpretation of the effective mass, effective masses in semiconductors, silicon and germanium
- 11 Intrinsic carrier concentration, intrinsic mobility, impurity conductivity, donor states, acceptor states,
- 12 Thermal ionization of donors and acceptors.
- 13 Diffusion in semiconductors
- 14 Diamagnetic and paramagnetic solids, magnetic susceptibilities of diamagnetic and paramagnetic substances,
- 15 Quantum theory of paramagnetism, Pauli paramagnetism of conduction electrons,
- 16 Quantum theory of ferromagnetism, antiferromagnetism and Ferrimagnetism
- 17 Introduction to superconductivity and types of superconductors, BCS theory, magnetic field induced superconducting to normal state transitions, parameters evidencing the superconducting phase transitions
- 18 free energy change during superconducting transition, London relations and coherence length of superconductor,
- 19 Quantized flux due to cooper pairs flowing in a ring, calculation of the sustaining time of supercurrents,
- 20 Thermodynamics of superconductors, Superconductors projected to AC/DC fields
- 21 Fabrication of junctions for Josephson effects, principle and theory of SQUIDS,
- 22 Electric polarization, calculation of macroscopic electric field, dielectric constant and polarizability,
- 23 phase transitions in ferroelectric crystals, differentiation of anti-ferroelectric, piezoelectric and ferro-elastic materials.

Recommended Texts

1. Pillai, S.O. (2005). *Solid states physics* (6th ed.). New Delhi: New age international limited.
2. Wahab, M. A. (2017). *Solid states physics: structure and properties of materials* (3rd ed.). Oxford: Alpha Science International.



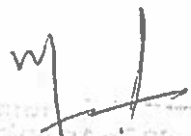
Suggested Readings

1. Ibach, H. & Lüth, H. (2009). *Solid states physics* (4th ed.). New York City: Springer.
 2. Ashcroft, N. W. & Mermin, N. D. (2003). *Solid state physics* (1st ed.). Hong Kong: CBS Publishing Asia.
- H. P. Myers. (2002). *Introductory solid states physics* (2nd ed.). Boca Raton: CRC Press.

PHYS-6125

Capstone Project

3(3-0)


Department of Physics
University of Burgundy



URCG-5130

Model Course Outline
for the Course Understanding of Quran – II

Course Title: Understanding of Quran – II
 Course Book: Muallim ul Quran (Volume 3, 4 & 5) by Dr Ubaid ur Rahman
 Credit Hours: 1 (0-1)
 Contact Hours: 3 per week
 Weeks: 15-16 (45-48 hours)

Course Learning Outcomes:

By the end of this course, students will be able to:

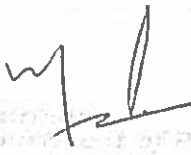

1. Directly comprehend hundreds of Quranic sentences & verses.
2. Understand at least 80 to 85 % of each page of the holy Quran.
3. Understand common verses across different Quranic topics.
4. Achieve proficiency in the basic and advance linguistic aspects of the Arabic language.
5. Understand the difference between Quranic verbs in various forms, such as present, past and imperative.
6. Develop the ability to understand long verses of the holy Quran independently and then comprehend their interpretation.

Provision of material, content and books:

- **Paper book:** All volumes are available in printed book form.
- **Tutorial videos:** Teaching video of each lesson available on YouTube.
- **Confirmation Videos:** A complete series of confirmation videos of all lessons is available in which the student can confirm his answers.
- **A flipbook:** A flipbook edition is also accessible.
- **Helping material:** Helping material for the teachers like quizzes, question papers and images is available on website.

Course Outline:

Weeks	Lectures	Units	Lessons	Assignments/Home Task	
1.	1.	5	6	Understanding & Translation of Verses	Present Tense صيغة جمع منكر غائب مثل يعبدون
	2.	6	7-8	Understanding & Translation of Verses	Present Tense صيغة جمع منكر غائب مثل يعبدون
2.	1.	6	9-10	Understanding & Translation of Verses	Present Tense صيغة مفرد منكر مخاطب (تعبد) وجمع منكر مخاطب (تعبدون)
	2.	6	11-12	Understanding & Translation of Verses	Present Tense صيغة جمع منكر مخاطب (تعبدون)


 Chairperson
 Department of Physics
 University of Sargodha


3.	1.	6	13	Understanding & Translation of Verses	صيغة المتكلم (أعبد) Present Tense
	2.	6	14-15	Understanding & Translation of Verses	صيغة جمع المتكلم (تعبد) Negative Imperative صيغة المفرد و صيغة الجمع , لا تعبدوا لا تعبدوا
4.	1.	6	16-17	Understanding & Translation of Verses	Conditional Sentences & masdar moawal (مصدر مؤول)
	2.	6	18-19	Understanding & Translation of Verses	Laam uttaleef (لام التعليل) & Laam ul Jhood (لام الجحود)
5.	1.	6	20-21	Understanding & Translation of Verses	Present with object pronouns & Passive Voice
	2.	6	Revision (Unit 6)	Quiz	
6.	1.	Unit 7	1 (sec 1-3)	Understanding & Translation of Verses	Past Tense صيغة المفرد للثاني
	2.	6	1 (Sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة المفرد للثاني
7.	1.	6	1 (Sec 5-6)	Understanding & Translation of Verses	Past Tense صيغة المفرد للثاني
	2.	6	1 (Sec 7-9)	Understanding & Translation of Verses	Past Tense صيغة المفرد للثاني
8.	1.	7	Revision	Understanding & Translation of Verses QUIZ	Past Tense صيغة المفرد للثاني
	2.			MID-TERM	
9.	1.	7	2 (sec 1-2)	Understanding & Translation of Verses	Past Tense صيغة الجمع للثاني عبادوا
	2.	7	2 (sec 3)	Understanding & Translation of Verses	Past Tense صيغة الجمع للثاني عبادوا
10.	1.	7	2 (sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة الجمع للثاني عبادوا
	2.	7	2 (sec 6-7)	Understanding & Translation of Verses	Past Tense صيغة الجمع للثاني عبادوا
11.	1.	7	3 (sec 1-2)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمتكلم عبادنا

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	2.	7	3 (sec 2-3)	Understanding & Translation of Verses	Past Tense صيغة الجمع المتكلم عينا
2.	1.	7	3 (sec 3-4)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمتكلم عينا
	2.	7	3 (sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمتكلم عينا
3.	1.	7	4 (sec 1-2-3)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمخاطب عينا
	2.	7	4 (sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمخاطب عينا
4.	1.	7	5-6	Understanding & Translation of Verses	Past Tense صيغة الجمع للمتكلم والمخاطب عينا ، عينا
	2.	7	7	Understanding & Translation of Verses Quiz	Past Tense صيغة المؤنث للغائب عينا
5.	1.	7	8	Understanding & Translation of Verses	Passive Voice (Past Tense) فعل مجهول للمفرد
	2.	7	9	Understanding & Translation of Verses	Passive Voice (Fast Tense) فعل مجهول الجمع
6.	1.	8	1-4	Understanding & Translation of Verses	Imperative Verb for singular فعل الأمر للمفرد
	2.	7	5-8	Understanding & Translation of Verses	Imperative Verb for plural فعل الأمر للجمع

OR

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 University of Sargodha

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Ethics-II

URCG-5132

1 (0-1)

1-Course Description

The course *Ethics-II* is designed to provide students with a deeper understanding of ethical principles and practices from both Semitic and non-Semitic religions, as well as their application in professional and social contexts. Students will engage with Jewish, Christian, Islamic, Hindu, Buddhist, Sikh, Confucian, and Jain ethical traditions. The course emphasizes moral reasoning, decision-making, tolerance, and peacebuilding. It aims to cultivate an inclusive, humanistic, and holistic approach towards ethical living and interfaith engagement.

2- Learning Objectives

The course objectives are to:

1. Understand the fundamental principles and theories of ethics.
2. Introduce the ethical and moral teachings of Judaism, Christianity, Islam, and Hinduism.
3. Explore the ethical teachings of non-Semitic religions such as Buddhism, Sikhism, Confucianism, and Jainism.
4. Develop critical thinking skills to evaluate ethical arguments and theories.
5. Promote ethical leadership and interfaith harmony.

3- Learning Outcomes

By the end of this course, students will be able to:

1. Identify and analyze major ethical theories and teachings from world religions.
2. Understand the role of religions in improving moral values and social behavior.
3. Demonstrate ethical decision-making in various personal and professional contexts.
4. Recognize the impact of ethical decisions on individuals, communities, and society.
5. Apply skills of ethical leadership, including communication, conflict resolution, and inclusive engagement.

4-Course Structure

1. Interactive lectures, Group discussions and debates
2. Reflection papers and presentations
3. Assignments and Quiz

Course Contents**Unit 1: Ethical Teachings of Semitic Religions**

- Judaism and its ethical teachings
- Christianity and its ethical teachings
- Islam and its ethical teachings

Unit 2: Ethical Teachings of Non-Semitic Religions

- Hinduism and its ethical teachings
- Sikhism and Buddhism: ethical values and practices
- Confucian and Jain ethical traditions

Unit 3: Professional Ethics

- Ethics for students and teachers
- Ethics in doctor-patient relationships
- Ethics in trader-customer interactions

Unit 4: Concept and Significance of Tolerance

- Definition, need, and importance of tolerance
- Teachings of Semitic religions on tolerance and their contemporary relevance
- Teachings of non-Semitic religions on tolerance and their contemporary relevance

Unit 5: Foundational Values and Ethics for Peacebuilding in Society

- Respect for sacred scriptures, personalities, places of worship, and religious symbols
- Promotion of tolerance and broadmindedness
- Encouragement of dialogue and harmony
- Benevolence towards humanity
- Establishment of justice and fairness
- Patience, forbearance, and forgiveness

Textbook

- Kidder, R. M. (2009). *How Good People Make Tough Choices: Resolving the Dilemmas of Ethical Living*. Harper.

Suggested Readings

1. Barash, D. P., & Webel, C. P. (2014). *Peace and Conflict Studies*. Sage.
2. Smart, N. (1998). *The World's Religions*. Cambridge University Press.
3. Nasr, S. H. (2003). *The Heart of Islam: Enduring Values for Humanity*. HarperOne.
4. Sharma, A. (2006). *Hindu Ethics: Purity, Abortion, and Euthanasia*. SUNY Press.
5. Harvey, P. (2000). *An Introduction to Buddhist Ethics: Foundations, Values and Issues*. Cambridge University Press.
6. Coward, H., & Perkinson, J. (2013). *A Cross-Cultural Dialogue on Ethical Leadership*. Wilfrid Laurier University Press.
7. Confucius. (1998). *The Analects*. Oxford University Press.

Semester-VIII

PHYS-6126

Computational Physics

3(3-0)

Computational Physics consists of techniques to approximate mathematical procedures. Approximations are needed because we either cannot solve the procedure analytically or because the analytical method is intractable. These techniques enable one to find the solutions of such problems by using computing technology. This course is designed to have an understanding of various computational and numerical techniques used in physics.

Course Learning Objectives:

On completion of this course, students should be able learn selected computational methods and can formulate a strategy to solve a given problem in physics using required computational methods along with their limitations. By using modern programming tools, they can independently use computers to program the problems in physics.

Course Contents:

1. A brief introduction to numerical analysis and different programming languages and packages.
2. A brief introduction to numerical analysis and different programming languages and packages
3. Basics of numerical computation
4. Principles of computer operations
5. Roots of equations (real roots by iterative method, Convergence Criterion of convergence, Newton Raphson method, Regula falsi method bisection method)
6. Numerical integration (Trapezoidal method, Truncation errors in Trapezoidal method, Simpson's method, Truncation errors in Simpson's method, and Gauss quadrature method)
7. Numerical solutions of ODEs (Euler's method, modified Euler's method, rk4 method)
8. Interpolation (Linear interpolation, interpolating polynomials, the Lagrange interpolating polynomial, finite differences, newton forward difference method, newton backward difference method, difference operators)
9. Numerical Differentiation (Finite Difference Approximations,)
10. Introduction to Python, Python basics
11. Variables and Basic Data Structures
12. Functions (Builtin and User defined)
13. Branching Statements (If-Else statements, Ternary Operators)
14. Iteration (For Loops, While Loops, List Comprehension)
15. Two and Three-Dimensional plots
16. Symbolic math using Sympy module
17. Implementation of numerical analysis using Python

Recommended Texts:

1. Peter, A. S. (1992). *Introduction to numerical methods* (2nd ed.). London: Macmillan Pub. Ltd.
2. Qingkai Kong, Timmy Siau & Alexandre M. Bayen (2011). *Python Programming and Numerical Methods: A Guide for Engineers and Scientists*. London: Academic Press.

Suggested Readings:

1. Jaan Kiusalaas (2013). *Numerical Methods in Engineering with Python 3*. New York: Cambridge University Press .
2. Macheown, P. K. & Merman, D. J. (1987). *Computational techniques in physics* (4th ed.). Bristol: AdmHilger.
3. T. Pang (2010). *Introduction to computational Physics*. New York: Cambridge University Press.
H. J. Gardner (2012), *Computational Physics*. Singapore: World Scientific.

In this course the students will get a basic understanding of the laser Physics, which have potential applications in optical spectroscopy, material processing, 3D imaging, and various branches of science. The course provides the physical foundations for lasers, including light-matter interaction phenomena (absorption, emission and dispersion), propagation of laser beams, laser resonators, rate equations for lasers, transient laser phenomena, principles and characteristics of cw and pulsed lasers, and some topical laser applications as a case study. Moreover, the course will treat some common types of laser in more details, including continuous-wave (cw) and pulsed, gas and solid state lasers.

Contents:

- 1 Introduction to Lasers, Properties of laser beam.
- 2 Electromagnetic waves and photons.
- 3 Energy levels, Transition and spectral lines, Spontaneous and Stimulated emission, Stimulated Absorption.
- 4 Line shape function, Black-Body Radiation, Relation between Einstein A and B Coefficients.
- 5 Conditions for large stimulated emissions.
- 6 Gain coefficient, Threshold Gain coefficient.
- 7 Line-broadening mechanism, The metastable level, Population inversion, The three and four-level system.
- 8 Rate equations, Optical resonators, Conditions for steady state oscillation in a two mirror Resonator.
- 9 Cavity resonance frequencies, Longitudinal and Transverse modes in a cavity.
- 10 Pumping Process, Pulsed vs Continuous emission, Threshold condition and output power, Optimum output coupling, Laser tuning.
- 11 Oscillation and pulsations in lasers, Q-Switching and mode-locking methods.
- 12 Phase velocity, Group Velocity, Dispersion and Pulse Width, Non-linear crystals.
- 13 Laser Systems (Solid state lasers, Ruby Laser, Nd:YAG and Nd:Glass lasers, Semiconductor lasers: Homojunction lasers, Double Hetrostructure lasers, Gass Lasers: Helium Neon laser, CO₂ laser, Nitrogen laser and Excimer laser, Free-Electro and X-ray lasers), Laser Applications

Recommended Books:

1. Silfvast, W. T. (2008). *Laser fundamentals*. New York: Cambridge University Press.
2. Milonni, P. W. & Eberly, J. (2010). *Laser physics*. New Jersey: John Wiley & Sons, Inc.

Suggested Readings:

1. Hecht, J. (2018). *Understanding lasers*. New Jersey: Wiley-IEEE Press.
2. Hooker, S. & Webb, C. (2010). *Laser physics*. Oxford: Oxford University Press.
3. Svelto, O. (2010). *Principles of lasers*. New York: Springer.
4. Haken, H. (2012). *Laser theory*. Heidelberg: Springer.
5. Avadhanulu, M. N. & Hemne, P. S. (2001). *An Introduction to lasers-theory and applications*. New Dehli: S. Chand Publishing.

Course Brief:

The course of Relativity and Cosmology is comprised of a wide range of topics from special relativity, general relativity and cosmology. It includes the topics starting from the very necessity of a new theory in the field of relativistic mechanics followed by answers to then questions from Einstein's special relativity. Later after the induction of acceleration in inertial frames, general relativity is discussed in details. Where special theory includes consequences of the theory and their experimental aspects, general theory is

discussed in this course with its required mathematics in manifold. In connection with cosmology, galaxies, their structures and kinds, mapping of clusters, big band theory like topics are also learnt to students.

Course Learning Objectives:

In this course, students will be introduced to the field of relativistic physics, learning about its history and its modern branches of study. This course provides students an insight of the principles of special theory of relativity and general theory of relativity and some of their main observational consequences (relativistic kinematics, higher dimensional space-time, cosmology, black holes and others). A student studying the course of Relativity and Cosmology will understand classical as well modern physics and will also acquire the skills to apply principles to new and unfamiliar problems. With this self-paced course, students get engaging lessons, expert instructors who make even the most challenging physics topics simple, and an excellent resource for getting a head start on student's physics graduate degree.

Course Contents:

- 1 Einstein's postulates of special relativity
- 2 Lorentz transformations
- 3 Relativity of simultaneity
- 4 Time dilation (twins paradox)
- 5 Length contraction (ladder paradox)
- 6 Velocity transformation and velocity addition
- 7 Relativistic mechanics
- 8 Minkowski space-time, line element
- 9 Four-vectors.
- 10 Conservation of energy and momentum
- 11 Elements of tensor calculus, manifolds and coordinates, curves and surfaces
- 12 Tensor fields, lie derivative
- 13 Geodesics, parallel transport
- 14 Riemann tensor, metric tensor, Christoffel symbols
- 15 General relativity, principles of general relativity
- 16 Equation of geodesics, Einstein's field equations
- 17 Cosmology, Newtonian cosmology, cosmological redshift
- 18 Hubble's law, the big bang, expansion rate.

Recommended Texts:

1. Cheng, T. (2015). *A college course on relativity and cosmology* (1st ed.). Oxford: Oxford University Press.
2. Forshaw, J. R. & Smith, A. G.(2009). *Dynamics and relativity* (1st ed.).New York:Wiley.

Suggested Readings:

1. McMohan, D. (2006). *Relativity demystified* (1st ed.).New York:Mc Graw-Hill.
2. McComb, W. D.(1999). *Dynamics and relativity* (2nd ed.). Oxford: Oxford University Press.
3. Narlikar,J. V.(2002). *Introduction to cosmology* (3rd ed.). Cambridge:Cambridge University Press.

PHYS-6129 Nuclear and Elementary Particle Physics 3(3-0)

In Nuclear physics we study about atomic nuclei and their constituents and interactions. Other forms of nuclear matter are also studied.Nuclear physics should not be confused with atomic Physics, which studies the atom as a whole, including its electrons.Particle Physics evolved out of nuclear physics.

Course Learning Objectives:

On successful completion of this course, students will be able to use their conceptual understanding of the Properties of Nucleus in order to describe the Nuclear Magnetic Moments, Nuclear Electric Quadropole Moment use their ability to manage and operate different kind of detector to detect the nuclear radiation have the knowledge about the particle accelerator and can use it to work on this machine for advance research apply this knowledge in practical situations apply this knowledge for the transformation of one element to another have the knowledge of elementary particle, their classification and interaction.

Course Contents:

- 1 Basic properties of nucleus: size and mass of the nucleus.
- 2 Nuclear spin, magnetic dipole moment, electric quadropole moment, parity and statistic.
- 3 Nuclear models, Liquid drop model, Weizacker semi empirical mass formula.
- 4 The nuclear shell model and its applications, collective nuclear model.
- 5 Detectors, Passage of charged particle through matter, ionization chamber, proportional counter, scintillation counter, semi-conductor detector, bubble chamber, cloud chamber.
- 6 Particle Accelerators: Linear accelerator, Van de Graff, Betatron, synchrocyclotron, Nuclear Forces, Yukawa theory, proton-proton and neutron-proton scattering, charge independence of nuclear force.
- 7 Introduction to particles, Fundamental Interactions, Classification of elementary particles.
- 8 Parameters of elementary particles, the massless bosons.
- 9 The leptons, the mesons, the baryons, the eight fold way, Quarks, color, charm

Recommended Texts:

1. Kenneth S. Krane (2008). Introductory Nuclear Physics.
2. Martin B R. (2006). Nuclear and Particle Physics, 2nd edition. New York: Wiley

Suggested Readings:

1. Wiedemann, H. (2007). Particle accelerator physics (2nd ed.). Berlin: Springer.
2. Krane, S. (1987). Introductory nuclear physics (3rd ed.). New Jersey: Wiley.
3. Bernardeau, F., Grojen, C. & Dalibard, J. (2007). Particle physics and cosmology. Amsterdam: Elsevier Science.

Optional Courses

PHYS-6130

Physical and Geometrical Optics

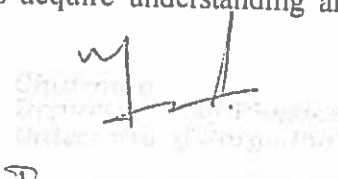
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Course Brief:

Optics is a branch of physics that deals with the determination of behavior and the properties of light, along with its interactions with the matter and also with the instruments which are used to detect it. There are two major branches of optics, physical and geometrical. Physical optics deals primarily with the nature and properties of light itself. Geometrical optics has to do with the principles that govern the image-forming properties of lenses, mirrors, and other devices that make use of light. This course is designed to help students gain an understanding of the fundamental principles of optics and photonics. It is primarily a theoretical course with some application to optical design. The course focuses on physical optics including the Fresnel Laws of refraction and reflection, interference, Fourier analysis and diffraction. This course also covers the basic concepts of geometrical ray optics and aberrated imaging needed in further optician education and professional work.

Course Learning Objectives:

The course aims to help students acquire understanding and a great deal of familiarity with

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fabrication of Zero dimensional and One dimensional nanomaterials using different Top Down (Lithography techniques e.g, Optical, e-beam and Nanoimprint Lithography) and Bottom Up (Wet chemical methods, e.g, Co-precipitation, Hydrothermal and Sol-Gel methods etc.) approaches. Last chapter is about different characterization techniques of nanomaterials to study their different properties e.g, Size, Shape, Surface morphology and Crystal structure of nanomaterials. These properties are very important to study, regarding application of nanomaterials in different fields.

Course Learning Objectives:

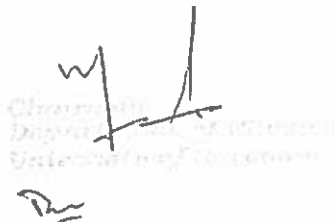
At the end of this course students will be able to learn

1. What is Nanophysics and Nanotechnology
2. Why we need Nanotechnology
3. What are Nanomaterials and their Types
4. Why Nanomaterials have extraordinary properties as compared to Macro-materials
5. Importance and Applications of carbon based nanomaterials (Graphene, Carbon Nanotubes)
6. Applications of Nanomaterials in Energy Sector (Fuel cells, Solar cells, Batteries, Biofuel)
7. How to prepare Zero Dimensional (0D), One Dimensional (1D) and Two Dimensional (2D) Nanomaterials
8. What are the challenges for nanotechnology regarding production, characterization and applications of nanomaterials and nanodevices.

Course Contents:

1. Introduction to Nano physics and Nanotechnology
2. Importance, Types of Nanomaterials w.r.t. Dimensions (0D, 1D and 2D Nanomaterials) and their Applications in Magnetic Data Storage and Semiconductor Chips,
3. Moore' Law (Miniaturization of devices on the Chip)
4. Origins of observed differences of properties of nano and macro materials
5. Carbon Based Nanomaterials (Graphene and Carbon Nanotubes): Introduction & Importance
6. Graphene (2D Nanomaterial): Properties and applications of graphene, Electrical & Thermal conductivity, Mechanical strength, Elasticity, Optical properties
7. Carbon Nanotubes (1D Nanomaterial) : Properties and applications of carbon nanotubes, Electrical & Thermal conductivity, Mechanical strength, Elasticity, Optical properties
8. Thin Film (2D Nanomaterials) Deposition Techniques: Introduction & Importance
9. Physical Vapour Deposition (PVD) Techniques: Pulsed Laser Deposition (PLD), Sputtering, Electron Beam Evaporation (EBE), Molecular Beam Epitaxy (MBE)
10. Chemical Vapour Deposition (CVD) techniques: Chemical vapour deposition
11. 0D & 1D Nanomaterials Fabrication Techniques: Introduction & Importance
12. Top Down Nanofabrication or Physical Fabrication Techniques: Optical lithography, Electron Beam Lithography, Nano Imprint Lithography
13. Bottom up Nanofabrication or Chemical Synthesis Techniques: Chemical reduction method, Hydrothermal method etc.
14. Nanostructures Characterization Techniques: Introduction & Importance
15. Surface Characterization or Analysis: Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM)
16. Structural Characterization or Analysis: X-ray diffraction (XRD)

Recommended Texts:

A handwritten signature is written over a circular official stamp. The stamp contains the text 'Department of Chemistry' and 'University of Calicut'.

1. Wolf, E. L. (2015). *Nanophysics and Nanotechnology: An introduction to modern concepts in Nanoscience*. New York: John Wiley & Sons.
2. Dongfang Yang (2023). *Thin Films-Deposition Methods and Applications, Canada*
3. Maria Benelmekki (2019). *Nanomaterials*, IOP Publishing, UK
4. Gerrard Eddy Jai Poinern (2015). *A Laboratory Course in Nanoscience and Nanotechnology*, CRC Press

Suggested Readings:

1. Wiesendanger, R. (2013). *Scanning probe microscopy: Analytical methods*. New York: Springer Science & Business Media.
2. Goldstein, J. I., Newbury, D.E., Michael, J. R., Ritchie, N. W., Scott, J. H., & Joy, D. C. (2017). *Scanning electron microscopy and X-ray micro analysis*. New York: Springer.

PHYS-6132

Methods of Experimental Physics

3(3-0)

The main objective of this course is to give students a brief introduction of some important experimental techniques related to experimental research in Physics which are currently being used in different modern research labs e.g, Vacuum and Sensor Technology. Vacuum is used in research or industrial labs to make ultra pure or contamination free samples at nanoscale to get required extraordinary properties of nanomaterials. Different types of sensors are used in research labs to measure different physical parameters e.g, pressure, temperature, magnetic field, fluid flow etc. Vacuum technology part of this course includes fundamental concepts of vacuum physics, Importance, Ranges and Applications of different ranges of vacuum, Creation and measurement of vacuum, Hurdles regarding creation of vacuum, Mathematical modeling of fluid dynamics and pumping process. This course also provides a comprehensive introduction to construction and working of different vacuum creation devices or vacuum pumps (Primary, Secondary and Ultra High Vacuum pumps) as well as vacuum measuring devices or vacuum gauges (Primary, Secondary and Ultra High Vacuum gauges). Sensor technology part of this course includes comprehensive introduction to construction and working of different types of sensors e.g, Temperature, Optical, Magnetic, Fluid flow sensors and Metal detectors etc.

Course Learning Objectives:

At the end of this course students will be able to learn:

1. Some important Experimental Techniques related to Experimental Research in Physics
2. What is Vacuum Physics and Vacuum Technology
3. What is Sensor Technology
4. Importance, Types and Ranges of Vacuum
5. Applications of different ranges of Vacuum
6. Fundamental concepts of Vacuum Physics
7. How to create a Vacuum (Construction and Working of different types of Vacuum pumps)
8. Hurdles regarding creation of vacuum
9. How to measure a Vacuum (Construction and Working of different types of Vacuum Guages)
10. Construction and Working of different types of Sensors

Course Contents:

1. Introduction to Vacuum Physics: Importance, Types of Vacuum (Rough, Medium, High, Ultra High and Extreme Vacuum) and Applications of all Types of Vacuum

2. Molecular Description of Gases: Kinetic Molecular Theory of Gases, Continuum and Molecular States of Gases, Mean Free Path, Molecular Number Density, Impingement Rate
3. Surfaces Processes: Scattering of a molecule from a surface, Adsorption and Desorption Processes and their Mathematical Modeling
4. Outgassing: Origins, Importance and Mathematical Modeling of Outgassing Rate due to Different Sources e.g, Desorption, Diffusion & Permeation
5. Sputtering: Mechanism, Factors affecting Sputtering Yield, Applications of Sputtering,
6. Gas Flow: Continuum and molecular flow of gases
7. Conductance and Pumping Speed, Mathematical modeling for conductance of long pipe for continuum and molecular flow regimes
8. Pumping process, Pump Down Time and Ultimate Pressure
9. Vacuum Pumps: Rotary & Root pumps, Turbo Molecular Pump, Ionic and Titanium Sublimation Pumps
10. Vacuum Gauges: Diaphragm & Capacitance Diaphragm Gauges, Spin Rotor, Penning & Magnetron Gauges
11. Sensor Technology: Temperature Sensors, Optical Sensors, Magnetic Sensors, Fluid Flow Sensors, Metal Detectors

Recommended Texts:

1. Chambers, A. (2004). *Modern vacuum physics* (1st ed.). London: CRC Press.
2. Fraden, J. (2010). *A Handbook of Modern Sensors: Physics, Design and Applications* (4th ed.). New York: Springer.

Suggested Readings:

1. Hoffman, D. M., Thomas, J. H., Singh, B. (1997). *Handbook of Vacuum Science and Technology*. London: Elsevier.
2. Yoshimura, N. (2007). *Vacuum Technology: Practice for Scientific Instruments*. New York: Springer.
3. Martin, L., Weissler, G.L., Carlson, R. W. (1979). *Methods of Experimental Physics. Vol 14: Vacuum Physics and Technology*. New York: Springer

PHYS-6133 Introduction to Quantum Computing 3(3-0)

Quantum computing is the use of quantum mechanical phenomena to perform computation and the computers performing quantum computations are known as quantum computers. These computers are supposed to perform much better than their contemporary counterparts. Quantum computation is a subfield of quantum information science. Quantum computing is the major impetus to the development of new general quantum technologies. This course offers a comprehensive introduction to quantum computing.

Course Learning Objectives:

The main objectives of this introductory course is to introduce the background material in mathematics and physics necessary to understand quantum computation and to develop in detail the central results of quantum computation.

Course Contents:

1. Computer technology and historical background
2. Basic principles and postulates of quantum mechanics: quantum states, evolution, quantum measurement, superposition, quantization from bits to qubits, operator function, density matrix, Schrödinger equation
3. Schmidt decomposition, EPR and bell's inequality

4. Quantum computation: quantum circuits
5. Single qubit operation
6. Controlled operations
7. Measurement
8. Universal quantum gates, single qubit and CNOT gates
9. Breaking unbreakable codes: code making
10. Trapdoor function, one time pad, RSA cryptography
11. Code breaking on classical and quantum computers, Schor's algorithm
12. Quantum cryptography: uncertainty principle
13. Polarization and spin basis, BB84, BB90, and Ekert protocols
14. Quantum cryptography with and without eavesdropping
15. Experimental realization
16. Quantum search algorithm

Recommended Texts:

1. Nielson, M. A. & Chuang, I. L. (2000). *Quantum computation and quantum information* (2nd ed.). Cambridge: Cambridge University Press.
2. McMahon, D. (2007). *Quantum computing explained* (1st ed.). New York: John Wiley & Sons.

Suggested Readings:

1. Bouwmeester, P., Ekert, A. & Zeilinger, A. (2000). *The physics of quantum information: quantum cryptography, quantum teleportation, quantum computation*. Berlin: Springer Verlag.
2. Williams, C.P. (2011). *Exploration in quantum computation* (2nd ed.). Springer Verlag.

Brylinsky, A. K. & Chen, G. (2002). *Mathematics of quantum computation*. London: Chapman & Hall/CRC.

PHYS-6134

Particle Physics ✓

3(3-0)

Particle physics has revolutionized the way we look at the universe. Along the way, it's made significant impacts on other fields of science, improved daily life for people around the world and trained a new generation of scientists and computing professionals. Because particle physics asks big questions—the biggest in all of science, we need new, unique and often very large equipment. Each year, tens of millions of patients receive X-ray, proton and ion therapy to treat cancer at more than ten thousand hospitals and medical facilities around the world. The aim of this course is of course; enable particle physicists to learn about the universe around us. Over the past half century, particle physicists have formulated the Standard Model, a beautiful framework that explains the visible universe from the smallest to the largest scales.

Course Learning Objectives:

Upon completion of this course, the student shall: - Be able to account for central concepts within particle physics, such as symmetries, invariants, and conservation laws. In addition, the student shall be able to use these concepts in practical calculations.

Course Contents:

- 1 Particle classification, quantum numbers
- 2 Leptons, hadrons, baryons, mesons, quarks
- 3 The fundamental interactions, the electromagnetic coupling, the strong coupling
- 4 The weak coupling
- 5 Symmetry transformation and conservation laws

- 6 Translation in space, rotation in space
- 7 The group $su(2)$, systems of identical particles, parity, iso-spin charge conjugation, time reversal
- 8 G parity, cpt theorem, the electromagnetic field, gauge invariance
- 9 Maxwell's equations, polarization and photon spin
- 10 Angular momentum, parity and c parity of photon
- 11 Hadron spectroscopy, formation experiment, partial wave formalism and the optical theorem
- 12 The Breit-Wigner resonance formula, baryon resonances, phase space considerations
- 13 Production experiments, the quark model, the group $su(3)$
- 14 Quarks, hadrons baryons, mesons in quark model, heavy meson spectroscopy
- 15 The quarkonium model
- 16 The standard model (qualitative treatment only)
- 17 Unification of weak and electromagnetic interactions
- 18 Glashow-Salam-Weinberg model

Recommended Texts:

1. Griffiths, D. (2008). *Introduction to elementary particles* (2nd ed.). Weinheim: Wiley
2. Riazuddin, Fayyazuddin (2012). *Quantum mechanics* (2nd ed.). Singapore: World Scientific.

Suggested Readings:

1. Povh, B. Rith, K. & Scholz, C. (2006). *Particles and nuclei: an introduction to the physical concepts* (5th ed.). Berlin: Springer.
2. Bjorken, J. D. & Drell, S.D. (1998). *Relativistic quantum mechanics* (1st ed.). New York: McGraw Hill.
- Halzen, F. & Martin, A. D. (1984). *Quarks and leptons* (1st ed.). New Jersey: Wiley.

PHYS-6135

Advanced Electronics ✓

3(3-0)

Course Brief:

Advanced Electronics is the course of zero and one. This course includes the theoretical and practical approach for designing of computer. This course starts with number system and their inter-conversions which is the basic for designing of a digital system. The course also contains different types of logic circuits, i.e., combinational logic and sequential logic circuits. The different types of counter and register circuits are designed. The basic architecture of microprocessor and microcontroller is discussed and the concepts of RAM and ROM along with designing are given

Course Learning Objectives:

After this course the students will be able to design the small or large digital circuits. They'll also be able to study the logic gates and implementation of Boolean functions using different logic families

Course Contents:

1. Number systems and operations (number systems their introversion).
2. Number Systems and Operations (Number systems their introversion) Codes (BCD, Excess-3, Gray) error detection and correction codes, Parity codes, Seven-segment Display Code.
3. Logic Gates and Related Devices, Logic Families- significance and types, Boolean Algebra and Simplification Techniques, Combinational Logic Design, Flip-Flops , Sequential Logic Circuits (Registers and application of shift register), Ripple Counters, Synchronous Counter, Microprocessors.

- 4 Introduction to Microprocessors, Inside a Microprocessor, Arithmetic Logic Unit (ALU), Register File, Control Unit, Basic Microprocessor Instructions, Data Transfer Instructions, Arithmetic Instructions, Logic Instructions, Discussion on 8085/8088, 8086 processor family.
- 5 Intel Microprocessor hierarchy, Microcontrollers, Introduction to the Microcontroller, applications, Inside the Microcontroller.
- 6 Central Processing Unit (CPU), Random Access Memory (RAM), Read Only Memory (ROM), Special-Function Registers.
- 7 Peripheral Components, Microcontroller Architecture, Architecture to Access Memory, Eight-Bit Microcontrollers, -Bit Microcontrollers.
- 8 32-Bit Microcontrollers, Interfacing (Peripheral Devices with a Microcontroller, LEDs, Electromechanical Relay, Keyboards Seven-Segment Displays), Modulation, Modulation; the power spectrum in AM, the diode modulator for AM, detection of AM signals, AVC, The SSB system of modulation, the frequency spectrum, bandwidth , generation of FM and AM.
- 9 The superhetrodyne receiver, a radar system.
- 10 Radio communication, Production of radio transmitter block diagram. Propagation of radio waves system Formation of ionosphere layers and their variations.

Recommended Texts:

1. Mano, M. M. (2017). *Digital logic and computer design* (5th ed.). New Delhi: Pearson.
2. Tokheim, R. L. (2013). *Digital electronics: principles and applications* (8th ed.). OH: MacGraw-Hill education

Suggested Readings:

11. .Floyd, T. L. (2014). *Digital fundamentals* (11th ed.). New Jersey: Prentice Hall, Pearson.
12. Morris, M., Michael, M. & Ciletti, D. (2013). *Digital design* (5th ed.). Upper Saddle River: Prentice Hall, Pearson.
13. Kumar, A. A. (2016). *Fundamentals of digital circuits* (4th ed.). New Delhi: PHI Learning.
14. Boylestad, R. & Nashelsky, L. (2002). *Electronic devices and circuit theory*. New Jersey: Pearson Prentice Hall.
15. Floyd, T. L. (2007). *Principles of electric circuits*. New Jersey: Pearson Prentice Hall.

W. L.

M.

Deficiency Courses

Course Code	Course Title	Credit Hours	Pre-Requisite
PHYS-5101	Mechanics	3(3-0)	Nil
PHYS-5102	Waves and Oscillations	3(3-0)	Nil
PHYS-5103	Introduction to Electromagnetism	4(3-1)	Nil
PHYS-5104	Modern Physics	3(3-0)	Nil
PHYS-5106	Theory of Thermodynamics	3(3-0)	Nil
MATH-5101	Calculus-I	3(3-0)	Nil
MATH-5104	Calculus-II	3(3-0)	Nil
MATH-5105	Linear Algebra	3(3-0)	Nil
MATH-5109	Ordinary Differential Equations	3(3-0)	Nil

PHYS-5101 **Mechanics** **Cr.H-3(3-0)**

Course Brief:

Mechanics is all about motion of a body. It deals with forces, motion and further to the laws of motion in inertial frames specifically. This course provides the students a broad understanding of the physical principles of the mechanics, to describe mechanical events that involve forces acting on macroscopic objects. The main objective of this course is to create quantitative skills in the students and to motivate them to think creatively and critically about scientific problems and experiments. Students are encouraged to share their thinking with teacher and the other students to examine different problem-solving strategies.

Course Learning Objectives:

After completion of the course, students will be able

- 1- To understand the basic concepts of mechanics, kinematics and dynamics.
- 2- To understand the specific knowledge in mechanics particularly Newton's Laws and applications, dynamics of the object and conservation theorem.
- 3- To develop problem solving approach to answer problems in applied physics.
- 4- To recognize and distinguish the various types of motion like rotational motion, planetary motion and their relevant concepts.

Course Contents:

- 1 Motion in one/two/three dimensions.
- 2 Newtonian mechanics, Friction, Drag force, Work and kinetic/potential energy.
- 3 Linear momentum, Conservation of momentum/energy, Power, System of particles, Collisions in one/two dimensions.
- 4 Rotational dynamics, Moment of inertia, Principles of parallel and perpendicular axis theorem.
- 5 Determination of moment of inertia of various shapes.
- 6 Rotational dynamics of rigid bodies and its effect on the application of torque.
- 7 Angular momentum and its conservation, Effect of torque on the angular momentum.
- 8 The motion of planets and Kepler laws in detail, Motion of satellite and its energy consideration in planetary and satellite motion.
- 9 Fluid statics, Fluid dynamics.

Recommended Books:

1. Halliday, D., Resnick, R. & Walker, J. (2014). *Fundamentals of physics* (10th Ed.). New York: Wiley.
2. Halliday, D., Resnick, R. & Krane, K. S. (2003). *Physics* (5th Ed.). New York: Wiley.

Suggested Books:

1. Young, H. D., Freedman, R. A. & Ford, A. L. (2019). *University physics* (15th Ed.). New York: Pearson.
2. Serway, R. A. & Jewett, J. W. (2014). *Physics for scientist and engineers* (9th Ed.). New York: Brooks/Cole.
3. Melissinos, A.C. (2008). *Experiments in modern physics*. New York: Academic press.

PHYS-5102

Waves and Oscillations ✓

3(3-0)

Course Brief:

This course includes the very necessary and fundamental concepts of oscillations in start to develop a logical foundation for the generation of waves in a medium and even in the absence of a medium i.e electromagnetic waves. Damped oscillations in connection with resonance are elaborated followed by types of waves in terms of their respective media for propagation. Characteristic features of mechanical waves including waves in a stretched string and sound waves are learnt to students that include speed of waves, superposition, resonances, harmonics and Doppler Effect, to mention a few. Later in case of electromagnetic waves, their generation, propagation in various media, diffraction, reflection and refraction like properties are also elaborated.

Course Learning Objectives:

This course provides students an insight of the principles of waves as carriers of energy including sound and optical waves mainly. A student studying this course will understand classical as well modern physics and will also acquire the skills to apply principles to new and unfamiliar problems. Students are encouraged to share their thinking with teachers and peers and to examine different problem-solving strategies, in the said field. Students will learn that waves come from many interconnected (coupled) objects when they are vibrating together. We will discuss many of these phenomena, along with related topics, including mechanical vibrations and waves, sound waves, electromagnetic waves and optics.

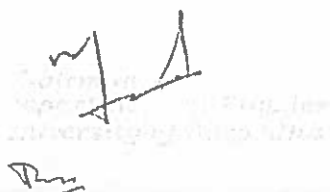
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Course Contents:

- 19 S.H.M and its application, energy consideration in S.H.M
- 20 S.H.M and uniform circular motion combination of harmonic oscillations
- 21 Damped harmonic oscillation, Forced oscillation, driven harmonic oscillation and resonance
- 22 Mechanical waves, traveling waves, linear wave equation, power & intensity in wave motion
- 23 Principle of superposition, standing waves, interference of waves, beats
- 24 Doppler effect & its applications, supersonic and shock waves
- 25 Measurement of speed of light by Roemer's and Fizeau's methods, reflection, refraction
- 26 Huygens's principle and its applications to reflection and refraction
- 27 Fermat's principle, conditions for interference
- 28 Young's double slit experiment, intensity distribution in double slit interference pattern, phasors
- 29 Interference from thin film
- 30 Introduction to diffraction pattern, single slit diffraction pattern
- 31 Intensity in single slit diffraction pattern using phasor, diffraction grating
- 32 X-ray diffraction
- 33 Polarization by selective absorption
- 34 Reflection.

Recommended Texts:

- 1 Resnick, R., Halliday, D. & Krane, K. S. (2002). *Physics* (5th ed.) New York: Wiley.
- 2 Halliday, D., Resnick, R. & Walker, J. (2014). *Fundamental of physics* (10th ed.) New York: Wiley.

A handwritten signature in blue ink is written over a circular official stamp. The stamp contains some text that is mostly illegible due to the signature and fading. The signature appears to be 'D. Walker'.

Suggested Readings:

1. Sears, F. W., Zemansky, M. W. & Young, H. D. (2000). *University physics* (8th ed.) Massachusetts: Addison-Wesley.
2. Alonso, M. & Finn, E. J. (1999). *Physics MA*: Addison-Wesley.
3. Serway, R. A. & Jewett, J. W. (2004). *Physics for scientists and engineers* (6th ed.). New York: Thomson Brooks.

PHYS-5103

Introduction to Electromagnetism ✓

4(3+1)

Course Brief:

PHYS-5103 gives an introduction in electromagnetism with emphasis on the following topics: Electric fields and currents, magnetic fields and induction, simple electrical circuits and electromagnetic oscillations.

Course Learning Objectives:

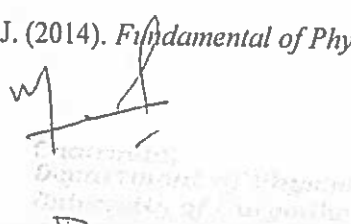
The objectives of this course are to tease out the laws of electromagnetism from our everyday experience by specific examples of how electromagnetic phenomena manifest themselves. The students would be able to describe, in words, the ways in which various concepts in electromagnetism come into play in particular situations and to predict outcomes in other similar situations. The overall goal is to use the scientific method to come to understand the enormous variety of electromagnetic phenomena in terms of a few relatively simple laws.

Course Contents:

1. Coulomb's law in vacuum, Electric field due to discrete/continuous charges distributions, Electric dipole, Electric flux, Gauss's law and its applications.
2. Electric potential due to discrete/continuous charges distributions.
3. Work and Electric potential energy.
4. Capacitors and capacitance, Capacitance for various geometries, Capacitance with Dielectrics, Energy transfer in electric circuit.
5. Power in electric circuits, Calculating current in a single loop and multiple loop by using Kirchhoff laws, Circuit analysis.
6. Growth and decay of current in RC-circuits and its analytical treatment. Magnetic field, Magnetic forces on a single point charge/current carrying conductor.
7. Torque on a current carrying loop and magnetic dipole, Biot & Savart Law and its analytical treatment and application.
8. Ampere's law and its applications, Electromagnetic induction and its laws.
9. Inductance, Inductance for various configurations, LR circuits, Growth and decay of current in RL circuits.
10. Electromagnetic Oscillation (Qualitative and Quantitative analysis using differential equations), Forced electromagnetic oscillations and resonance.
11. Alternating current circuits, Single loop RLC circuits (series and parallel), Power in AC circuits and phase angles
12. Measurement of resistance using a Neon flash bulb and condenser
13. Conversion of a galvanometer into Voltmeter & an Ammeter
14. To determine the self inductance of given coil.
15. To determine the mutual inductance b/w two coils.
16. To determine frequency of AC supply by electromagnetic sonometer/ Melde's experiment.
17. Measurement of low resistance coil by a Carey Foster Bridge.

Recommended Texts:

1. Halliday, D., Resnick, R. & Walker, J. (2014). *Fundamental of Physics* (10th ed.). New York: Wiley.

A handwritten signature is written over a faint circular stamp. The stamp contains the text "Department of Physics" and "University of..." in a circular arrangement. Below the stamp, the number "17" is written.

- Halliday, D., Resnick, R. & Krane, K. S. (2003). *Physics* (5th ed.). New York: Wiley.

Suggested Readings:

- Young, H. D., Freedman, R. A. & Ford, A. L. (2019). *University physics* (15th ed.). New York: Pearson.
- Ohanian, H. C. & Markert, J. T. (2006). *Physics for engineers and scientists* (3rd ed.). New York: W. W. Norton.
- Serway, R. A. & Jewett, J. W. (2014). *Physics for scientist and engineers* (9th ed.). New York: Brooks/Cole.

PHYS-5104

Modern Physics

3(3-0)

The modern physics also termed as post-Newtonian concepts in physics deals with the major advances made in the twentieth century. To get the correct understanding of the natural world, we still use these ideas as given in the course contents.

Course Learning Objectives:

The purpose of this course is to provide students with a foundation in the concepts, fundamental principles and analytic techniques needed to solve problems arising in the context of contemporary physics.

Course Contents:

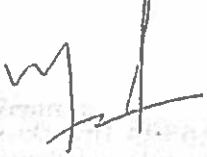
- Black Body Radiation.
- Plank's Radiation Law and Quantum of Energy, Derivation of Stefan's Law and Wien's Displacement Law from Planck's Radiation Law.
- Quantization of Energy, Light Quantization and Photoelectric Effect. The Compton Effect.
- Wave Nature of Matter and de-Broglie Hypothesis and its Experimental Verification, Wave Packet and its Localizations in Space and Time.
- Hydrogen Spectrum, Bohr Theory of Atomic Structure, Deficiencies of the Bohr Model,
- Bohr Correspondence Principle, Experimental Evidence for Quantization and Determination of Critical Potential (Frank-Hertz Experiment).
- Nuclear Structure and the Basic Properties of the Nucleus (Nuclear Size, Binding Energy, Angular Momentum of the Nucleus.
- Magnetic Moment and parity) Meson Theory of Nuclear Force.
- Radioactivity and Laws of Radioactive Decay, Conservation Laws in Radioactive Decays. Radioactive Isotopes and Carbon Dating.
- Nuclear Reactions and Q-values, The Compound Nucleus, Nuclear Fission and Fusion Applications of Nuclear Physics.

Recommended Texts:

- Halliday, D. Resnick, R. & Walker, J. (2014). *Fundamentals of physics* (10th ed.). New York: Wiley.
- Halliday, D. Resnick, R. & Krane, K. S. (2003). *Physics* (5th ed.). New York: Wiley.
- Young, H. D., Freedman, R. A. & Ford, A. L. (2019). *University physics* (15th ed.). New York: Pearson.

Suggested Readings:

- Beiser, A. (2003). *Concepts of modern physics* (6th ed.). New York: McGraw Hill.
- Serway, R. A. & Jewett, J. W. (2019). *Physics for scientist and engineers* (10th ed.). New York: Cengage Learning.


Chairman
Department of Physics
University of Jammu
Jammu

Thermodynamics literally means heat in motion. The subject of thermodynamics deals with transformation of heat energy into mechanical energy and vice versa. It describes processes that involve changes in temperature, transformation of energy, relationships between heat and work. To get a deeper insight and understanding into the laws of thermodynamics, the molecular concept of matter is incorporated into the study of thermodynamics by means of statistical mechanics. Objectives of this course are to enable students to be conversant with the terminology associated with thermodynamics. They can understand the origin of heat and temperature, the basic laws of thermodynamics, the applications of these laws for analyzing and controlling the thermodynamic system.

Course Learning Objectives:

At the end of this course students will have basic knowledge of climate changes as a result of global warming around the globe, flow of energy in the form of heat in different substances, composition of atmosphere around the earth, laws of thermodynamics, working principle of heat engine, refrigerator, air conditioner and heat pumps. They will also be able to understand the Time flow in everyday life.

Contents:

- 1 Kinetic theory of gases, derivation of fundamental equation of kinetic theory of gases. Phase transition and phase diagram.
- 2 Maxwell distribution of molecular speeds and energies, modification of kinetic theory for real gas, the Van der Waal's equation, Zeroth law of thermodynamics and thermodynamic equilibrium.
- 3 Thermodynamic processes and types of thermodynamic systems. First law of thermodynamics, Its Consequences, applications on different types of systems and work-energy calculations.
- 4 Second law of thermodynamics and the concept of entropy, entropy measurements for reversible and irreversible process.
- 5 Combined first and second law of thermodynamics, entropy changes in the ideal gases.
- 6 Carnot cycle and efficiency measurements.
- 7 The Joule-Thomson experiment.
- 8 The third law of thermodynamics and its consequences. Free energy.
- 9 Thermodynamic Potentials and Maxwell relations.
- 10 Transfer of heat and its distribution, Mean free path and microscopic calculations of mean free path.
- 11 Thermoelectricity

Recommended Books:

1. Halliday, D., Resnick, R. & Krane, K. S. (2016). *Physics* (5th ed.). New York: Wiley
2. Young, H. D., Freedman R. A., Ford, A. L., Seers, F. W. & Zemansky, P. (2008). *University physics* (13th ed.). San Francisco: Addison Wesley.

Suggested Books:

1. Serway, R. A. & Jewett, J. W. (2019). *Physics for scientist and engineers* (10th ed). New York: Cengage Learning.
2. Halliday, D., Resnick, R. & Walker, J. (2014). *Fundamental of physics* (10th ed.). New York: Wiley.
3. Garg, S. C., Bansal, R.M. & Ghosh, C.K. (2012). *Thermal physics* (2nd ed.). India: McGraw Hill Education.

Calculus is the mathematical study of continuous change. If quantities are continually changing, we need calculus to study what is going on. Calculus is concerned with comparing quantities which vary in a non-linear way. It is used extensively in science & engineering, since many of the things we are studying (like velocity, acceleration, current in a circuit) do not behave in a simple, linear fashion. Calculus has two major branches, differential calculus (Calculus-I) & integral calculus (Calculus-II); the former concerns instantaneous rates of change, & the slopes of curves, while integral calculus

concerns accumulation of quantities, & areas under or between curves. This is the first course of the sequence, Calculus-I, II & III, serving as the foundation of advanced subjects in all areas of mathematics. The sequence, equally, emphasizes basic concepts & skills needed for mathematical manipulation. It focuses on the study of functions of a single variable. Calculus-I is an introduction to differential & integral calculus: the study of change.

Contents

- 1 Functions & their graphs, Rates of change & tangents to curves
- 2 Limit of a function & limit laws, the precise definition of a limit
- 3 One-sided limits, continuity, Limits involving infinity; asymptotes of graphs
- 4 Differentiation: tangents & derivative at a point, the derivative as a function
- 5 Differentiation rules, the derivative as a rate of change
- 6 Derivatives of trigonometric functions, Chain rule, implicit differentiation
- 7 Related rates, linearization & differentials, higher derivatives
- 8 Applications of derivatives: extreme values of functions
- 9 Rolle's theorem, the mean value theorem, Monotonic functions & the first derivative test
- 10 Convexity, point of inflection & second derivative test, Concavity & curve sketching
- 11 Applied optimization, Antiderivatives, integration: area & estimating with finite sums
- 12 Sigma notation & limits of finite sums, definite integral, the fundamental theorem of calculus
- 13 Indefinite integrals & the substitution method, Substitution & area between curves
- 14 Applications of definite integrals: volumes using cross-sections
- 15 Volumes using cylindrical shells, arc length, Areas of surfaces of revolution
- 16 Transcendental functions: inverse functions & their derivatives
- 17 Natural logarithms, exponential functions, Indeterminate forms & L'Hôpital's rule
- 18 Inverse trigonometric functions, hyperbolic functions

Recommended Texts

1. Thomas, G.B., Weir, M. D., & Hass J. R. (2014). *Thomas' calculus: single variable* (13th ed./Latest). London: Pearson.
2. Stewart, J. (2015). *Calculus* (8th ed. /Latest). Boston: Cengage Learning.

Suggested Readings

1. Anton, H., Bivens I. C., & Davis, S. (2016). *Calculus* (11th ed. /Latest). New York: Wiley.
2. Goldstein, L. J., Lay, D. C., Schneider, D. I., & Asmar, N. H. (2017). *Calculus & its applications* (14th ed.). London: Pearson.
3. Larson, R., & Edwards, B. H. (2013). *Calculus* (10th ed. /Latest). New York: Brooks Cole.

MATH-5104

Calculus-II ✓

3(3-0)

This is the second course of the basic sequence Calculus serving as the foundation of advanced subjects in all areas of mathematics. The sequence, equally, emphasizes basic concepts & skills needed for mathematical manipulation. As continuation of Calculus-I, it focuses on the study of functions of a single variable. This Core Curriculum course is designed to meet the following four learning goals: Students will construct and evaluate logical arguments. Students will apply and adapt a variety of appropriate strategies to solve mathematical problems. Students will recognize and apply mathematics in contexts outside of mathematics. Students will organize and consolidate mathematical thinking through written and oral communication. Students will integrate transcendental functions, including logarithms, exponential, trigonometry and inverse trigonometric, hyperbolic and inverse hyperbolic functions, apply methods of integration, such as algebraic substitution, trigonometric substitution, partial fractions, integration by parts, and use a table of integrals, solve limit problems involving

indeterminate forms with La'Hopital's Rule and convert parametric representation of curves to rectangular coordinates, represent a curve using polar coordinates, and integrate functions expressed in polar coordinates.

Contents

- 1 Techniques of integration: Using Basic Integration Formulas, Integration by Parts
- 2 Trigonometric Integrals, Trigonometric Substitutions
- 3 Integration of Rational Functions by Partial Fractions
- 4 Integral Tables & Computer Algebra Systems, Numerical Integration, Improper Integrals
- 5 Sequences & Infinite Series, The Integral Test, Comparison Tests
- 6 Absolute Convergence, The Ratio & Root Tests
- 7 Alternating Series & Conditional Convergence
- 8 Power Series, Taylor & Maclaurin Series, Convergence of Taylor Series
- 9 The Binomial Series & Applications of Taylor Series
- 10 Parametrizations of Plane Curves
- 11 Calculus with Parametric Curves, Polar Coordinates
- 12 Graphing Polar Coordinate Equations
- 13 Areas & Lengths in Polar Coordinates, Conic Sections, Conics in Polar Coordinates

Pre-requisite: Calculus-I

Recommended Texts

- 1 Thomas, G. B., Weir, M. D., & Hass, J. R. (2014). *Thomas' calculus: single variable* (13th ed. /Latest). London: Pearson.
- 2 Stewart, J. (2012). *Calculus*, (8th ed. /Latest). New York: Cengage Learning.

Suggested Readings

- 1 Anton, H., Bivens, I. C., & Davis, S. (2016). *Calculus*, (11th ed. /Latest). New York: Wiley.
- 2 Goldstein, L. J., Lay, D. C., Schneider, D. I., & Asmar, N. H. (2017). *Calculus & its applications* (14th ed.). London: Pearson.
- 3 Larson, R., & Edwards, B. H. (2013). *Calculus* (10th ed. /Latest). New York: Brooks Cole.

MATH-5105

Linear Algebra ✓

3(3-0)

Linear algebra is the study of linear systems of equations, vector spaces, and linear transformations. Solving systems of linear equations is a basic tool of many mathematical procedures used for solving problems in science and engineering. Linear Algebra plays a significant role in many areas of mathematics, statistics, engineering, the natural sciences, and the computer sciences. It provides a foundation of important mathematical ideas that will help students be successful in future coursework. The main objective of this course is to help students to learn in rigorous manner, the tools & methods essential for studying the solution spaces of problems in mathematics and in other fields & develop mathematical skills needed to apply these to the problems arising within their field of study and to various real-world problems. The student will become competent in solving linear equations, performing matrix algebra, calculating determinants, finding eigenvalues & eigenvectors and the student will come to understand a matrix as a linear transformation relative to a basis of a vector space.

Contents

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 Department of Mathematics
 University of Jordan

- 1 Representation of linear equations in matrix form
- 2 Solution of linear system, Gauss-Jordan & Gaussian elimination method
- 3 Vector space, definition, examples & properties
- 4 Subspaces, Linear combination & spanning set
- 5 Linearly Dependent & Linearly Independent sets
- 6 Bases & dimension of a vector space
- 7 Intersections, sums & direct sums of subspaces, Quotient Spaces, Change of basis
- 8 Linear transformation, Rank & Nullity of linear transformation
- 9 Matrix of linear transformations
- 10 Eigen values & eigen vectors, Dual spaces
- 11 Inner product Spaces with properties, Projection
- 12 Cauchy inequality
- 13 Orthogonal & orthonormal basis
- 14 Gram Schmidt process & diagonalization

Recommended Texts

1. Dar, K.H. (2007). *Linear algebra* (1st ed.). Karachi: The Carwan Book House.
2. Kolman, B., & Hill, D. R. (2005). *Introductory linear algebra* (8th ed.). London: Pearson/Prentice Hall.

Suggested Readings

1. Cherney, D., Denton, T., Thomas, R., & Waldron, A. (2013). *Linear algebra* (1st ed.). California: Davis.
2. Anton, H., & Rorres, C. (2014). *Elementary linear algebra: applications version* (11th ed.). New York: John Wiley & Sons.
3. Grossman, S. I. (2004). *Elementary linear algebra* (5th ed.). New York: Cengage Learning.

MATH-5109

Ordinary Differential Equations ✓

3(3-0)

This course introduces the theory, solution, & application of ordinary differential equations. Topics discussed in the course include methods of solving first-order differential equations, existence & uniqueness theorems, second-order linear equations, power series solutions, higher-order linear equations, systems of equations, non-linear equations, Sturm-Liouville theory, & applications. The relationship between differential equations & linear algebra is emphasized in this course. An introduction to numerical solutions is also provided. Applications of differential equations in physics, engineering, biology, & economics are presented. The goal of this course is to provide the student with an understanding of the solutions & applications of ordinary differential equations. The course serves as an introduction to both nonlinear differential equations & provides a prerequisite for further study in those areas.

Contents

- 1 Introduction to differential equations: Preliminaries & classification of differential equations
- 2 Verification of solution, existence of unique solutions, introduction to initial value problems
- 3 Basic concepts, formation & solution of first order ordinary differential equations
- 4 Separable equations, linear equations, integrating factors, Exact Equations
- 5 Solution of nonlinear first order differential equations by substitution, Homogeneous Equations,

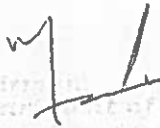
- 6 Bernoulli equation, Riccati's equation & Clairaut equation
- 7 Modeling with first-order ODEs: Linear models, Nonlinear models
- 8 Higher order differential equations: Initial value & boundary value problems
- 9 Homogeneous & non-homogeneous linear higher order ODEs & their solutions, Wronskian,
- 10 Reduction of order, homogeneous equations with constant coefficients,
- 11 Nonhomogeneous equations, undetermined coefficients method, Superposition principle
- 12 Annihilator approach, variation of parameters, Cauchy-Euler equation,
- 13 Solving system of linear differential equations by elimination
- 14 Solution of nonlinear differential equations
- 15 Power series, ordinary & singular points & their types, existence of power series solutions
- 16 Frobenius theorem, existence of Frobenius series solutions
- 17 The Bessel, Modified Bessel, Legendre & Hermite equations & their solutions
- 18 Sturm-Liouville problems: Introduction to eigen value problem, adjoint & self-adjoint operators,
- 19 Self-adjoint differential equations, eigen values & eigen functions
- 20 Sturm-Liouville (S-L) boundary value problems, regular & singular S-L problems

Recommended Texts

- 1 Boyce, W. E., & DiPrima, R. C. (2012). *Elementary differential equations & boundary value problems* (10th ed.) USA: John Wiley & Sons.
- 2 Zill, D.G., & Michael, R. (2009) *Differential equations with boundary-value problems* (5th ed.) New York: Brooks/Cole.

Suggested Readings

- 1 Arnold, V. I. (1991). *Ordinary differential equations* (3rd ed.). New York: Springer.
- 2 Apostol, T. (1969). *Multi variable calculus & linear algebra* (2nd ed.). New York: John Wiley & sons.


 Chairman
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